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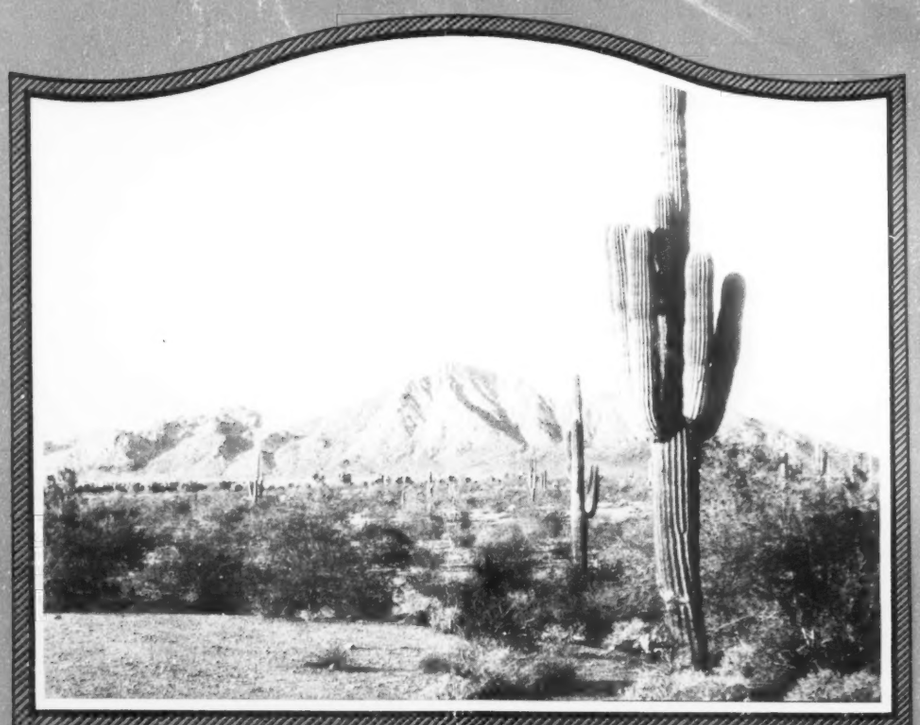

HOW ARIZONA'S ARID LANDS LOOK BEFORE IRRIGATION HAS TRANSFORMED THEM INTO AMAZINGLY FRUITFUL AREAS

Meteor Crater Today a Scene of Renewed Activity
R. G. Skerrett

Richtersveld Retains Age-Old Hold on Its Copper Hoard
Owen Letcher

Hotel Built of Concrete Blocks Pneumatically Tamped
A. S. Taylor

Building a Spectacular Mountain Road in California
S. G. Roberts

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More contractors each day are adopting the new I-R Riveting Hammers because of their superior performance

Size 9A Riveter and No. 7 Combination Riveter in use on 1¼" rivets on Point Bridge, Pittsburgh, Pa.

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Meteor Crater Again a Scene of Activity

This Peculiar Formation in the Desert of Northern Arizona Has Been of Scientific Interest for Many Years

PART I

By R. G. SKERRETT

WHAT would happen if a comet hit the earth? This question has been asked on many occasions by a perturbed public when some comet has trailed its luminous course across the sky. Strange as it may seem, we have an answer to this query, and right here in our own country. We refer to Meteor Crater in northern central Arizona, where exploratory work is now underway that has for its quest a mass of metals that fell from space possibly within the last 2,000 years. That crater was dug when the head of a comet, that is, a closely compacted cluster of iron meteorites, collided with the earth.

Meteor Crater—for a long time called Coon Mountain or Coon Butte—has outwardly the appearance of a circular hill, well over a mile in diameter and rising at its highest point 130 feet above the generally flat expanse of the surrounding desert area of Coconino County. Upon closer inspection, the top of the hill is found to be the rim of a cavernous hollow 570 feet deep, 4,000 feet across from east to west, and with a maximum diameter of 4,200 feet on an axial line running WNW. to ESE.

The cluster of meteorites that excavated that awesome basin weighed, in all probability, many millions of tons, and possessed the tremendous energy needful to penetrate, in its slanting flight, more than 2,500 feet of solid rock and to dig for itself a resting place that required the excavating of substantially 400,000,000 tons of rock fragments in the course of only a fraction of a second!

The foregoing statement sums up broadly the origin and some of the outstanding characteristics of Meteor Crater. Despite the fact that there are many fascinating angles to this subject we must confine ourselves only to the most important of them because of the limited space at our disposal in these pages. But it is interesting to recall that the Indians of the region have a legend that one of their gods, in the dim past, hurled himself out of the sky and hit the earth, amid a thunderous blaze, just where Meteor Crater survives; and it is a fact that none of the Indians will remove or use any of the iron meteorites to be found thereabouts because it is their belief that the god does not wish to be disturbed. Even so, white men have picked up and carried away in the last four decades several tons of the superficial remnants of the colliding meteoric mass.

A STRANGE band in the observed spectrum of the sun revealed the existence of helium there 60-odd years ago and nearly three decades before it became a laboratory curiosity in this world of ours.

Conversely, a so-called crater in the desert region of northern central Arizona may be the means of solving the origin of the deep cavities that mar the fair face of the moon. We refer to that peculiar formation in Coconino County which has figured in the legends of the Indians of that region for many generations.

Despite the skepticism of many scientists, it seems probable that what happened hundreds, if not thousands, of years ago in Arizona may likewise have occurred in a vastly more remote past when the moon was struck by wandering celestial bodies. Thus, Meteor Crater, besides yielding valuable metals that originated somewhere in limitless space, may help to confirm the belief that similar agencies brought into being the craters of the moon—in this way advancing the science of the creation of the universe.

It is a matter of record that some scientists have contended that Meteor Crater was produced by a volcanic action; and there are those that are still reluctant to accept any other explanatory theory. Present knowledge of the true nature of Meteor Crater is due to the labors and the research of a small group of experts, inspired by the leadership of Daniel Moreau Barringer, of Philadelphia, Pa., a well-known mining engineer and geologist. He studied the facts in connection with Coon Mountain in 1903 with an associate, B. C. Tilghman, to whom he had communicated his suspicion that this great so-called crater was an impact crater and not due to a steam explosion of volcanic origin—as had been commonly believed among scientists until proof to the contrary was adduced by Mr. Barringer and his associate.

Mr. Barringer had heard in 1902, from an acquaintance, that large quantities of meteoric iron had been found in the immediate vicinity of Coon Mountain; and, with an eye to the possible commercial development of the nickeliferous iron, as well as to the making of a scientific discovery of great importance, he and Mr. Tilghman located the mountain under the United States Mineral Land Laws. Their subsequent investigations of the site produced an astonishing array of proof which has fully confirmed the theory that the great hole was caused by a stupendous mass that came with cometary speed out of the vast beyond. The foundation for this belief has been laid, stone by stone, and represents an accumulation of facts garnered at great ex-

From rim to rim of this imposing basin is a distance of fully three quarters of a mile. In the middle of this depression may be seen the headframe reared during the first effort to sink a shaft deep enough to reach the erroneously assumed position of the buried meteoric mass.

pense over a period of more than 25 years. The cost of the early exploration work, which proved the impact origin of the crater, was borne by Messrs. Barringer and Tilghman.

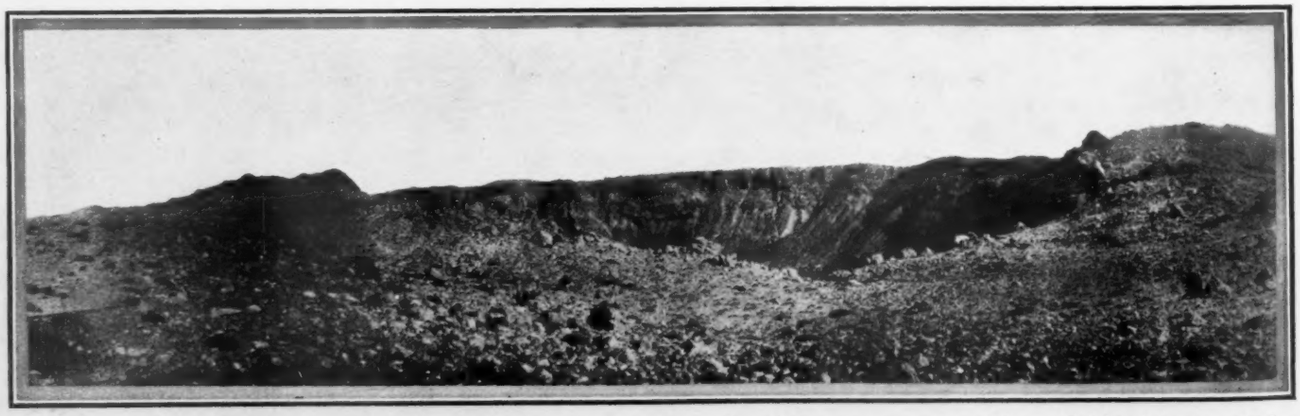
The story of Meteor Crater thus revealed is an absorbing one; and it is not hard to understand how the spell of it, the scientific interest as well as the possibility of utilizing the meteoric metals, gripped Mr. Barringer and kept him steadily on his quest when others were disposed to scoff at his zeal and at his faith in ultimate success.

There is no positive way of determining when the comet was diverted from its age-long orbit in space and caught by the attractive power of the earth. It must have been more than 700 years ago, because on the rim of the crater there was found a cedar tree with annual growth rings indicating that age. Again, the small amount of chemical erosion of the edges of broken fragments of rock, especially those of limestone, is evidence that the period was less than 5,000 years ago. The survival of the Indian legends may assign the collision to a time 1,000 to 2,000 years gone.

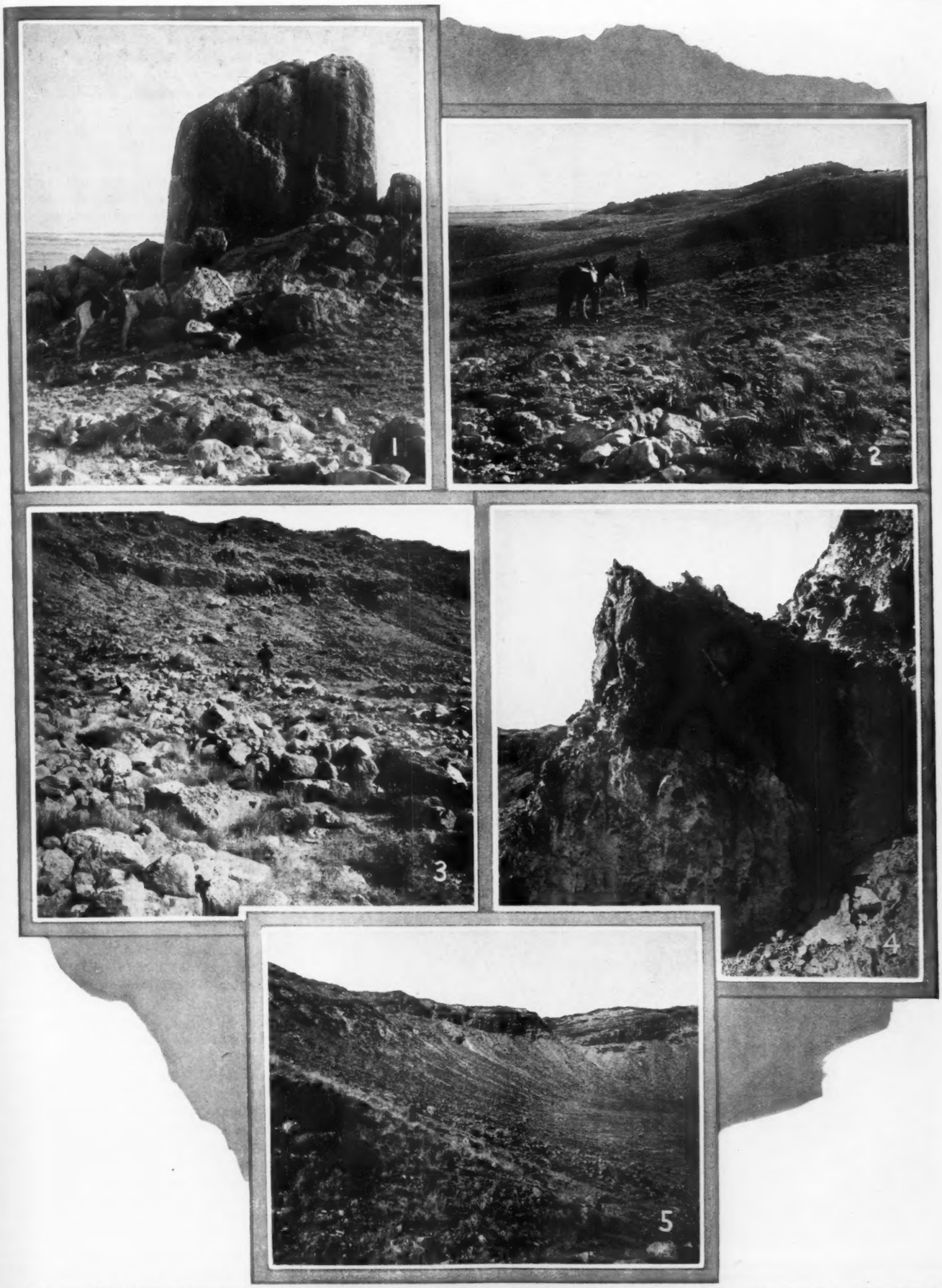
The desert region of that part of Arizona has been so eroded in the course of the ages that there is generally only a thin overburden of sand or soil—with here and there remnants, isolated buttes, of a thin bed of purplish red sandstone—resting upon the underlying limestone, which is 250 feet thick. All the formations are horizontal, except where disturbed at Meteor Crater. Beneath the bed of limestone is a horizontal stratum of comparatively soft, very white sandstone—remarkably free from impurities and known as saccharoidal sandstone. This stratum is from 800 to 1,000 feet in thickness; and supporting it there is a massive and very thick bed of hard, red sandstone, known as the Red Beds. Its thickness at the locality is not known, but is estimated to be at least 1,000 feet thick. Such was the rocky obstacle standing in the path of the comet when it was tripped in its celestial course and turned earthward. Despite the preliminary barrier of the earth's atmosphere, the comet was able to bore its way into the rocky crust of the earth until it was finally halted by the resistance of the hard, red sandstone, into the upper part of which it may have buried itself. Man's puny efforts with rock drills to probe the heart of the crater so as to discover the secret of its origin—work extending over a period of years and amounting relatively to little more than pin pricks—have served merely to emphasize the awesome and immeasurable forces exerted in forming that vast crater in a very brief fraction of time.

The evidence goes to show that the comet was not a single metallic unit, but an aggregation of many associated bodies—individual iron meteorites—that were held together in a compact group by reciprocal attractive powers. As a result of this grouping and consequent intermittent attrition, each of these bodies became more or less spherical or oval in form. Mr. Barringer has aptly termed them "celestial cobblestones" in one of his scientific papers. The bodies were of different sizes—the largest probably weighing many tons and the smallest being no heavier than a few ounces. This aggregation, or comet, swept through interplanetary space at a velocity of about 26 miles a second—that is, 1,560 miles a minute!

Meteor Crater would not have been formed nor the countryside bespattered for five miles around and no farther with many thousands of small meteoric masses had not the comet been caught in the meshes of the earth's gravitative force so that it fell where it did. Such bodies might strike the earth anywhere, as, for example, the great 1908 fall in Siberia. Undoubtedly, countless small members of the meteoric aggregation were burned up and converted to dust—that is, iron oxide—in their passage through the atmosphere. Indeed, this is what ordinarily happens to meteorites as they approach the earth, for otherwise we should hear more of the estimated many hundreds of millions of meteoric



Looking into the crater from a point a short distance back from the rim of the cavernous formation. Faithful as they are in many ways, photographs of Meteor Crater do not correctly portray the true magnitude and awesomeness of this great cavity in the desert region of northwestern Arizona.



1—A monster block of limestone thrown out of the crater when the comet was digging a grave for itself. 2—This outer slope of the crater is composed of the rocky materials excavated while the comet was burrowing into the depths of the desert. 3—An area of the inner slopes of the crater plainly indicating the destructive forces at work during the formation of that immense basin. 4—Where the face of the inner rim of the crater stands nearly straight up and down. 5—The inside of the crater bears mute testimony to the stupendous energy expended there in the dim past.

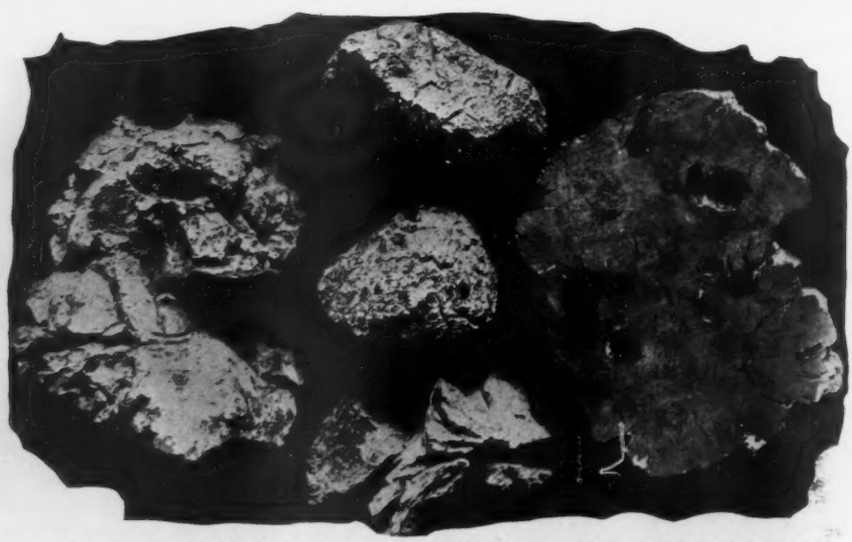
Small siderites, weighing several pounds, gathered near Canyon Diablo. These siderites were once the centers of larger masses of shale-ball iron.

bodies that fall upon our globe each year. This fact makes it all the more amazing that enough of the monster meteoric mass succeeded, after traversing our atmosphere from a northerly direction, in digging the great hole it did in the desert of Arizona.

In the depths of space, where the prevailing temperature is 459° below zero of the Fahrenheit scale, all meteoric bodies are chilled to their very cores; and it is not until they encounter the resistance offered by our atmosphere that they become superficially heated to the point of incandescence and appear as luminous bodies, many of them as small as grains of sand. Comets in space are visible only because of the reflected sunlight. Assuming that the resistance of the atmosphere was sufficient to slow up the Arizona comet's descent so that its rate of travel was only two to four miles a second when it hit the ground, it is self-evident that the slanting and therefore long journey through our atmosphere must have been compassed within a very few seconds. It follows, accordingly, that even though the surfaces of the individual bodies of the head of the comet were fused by the heat of friction, still that heat penetrated but slightly into the interiors of the frigid meteorites—this heat being quickly dissipated after the main body came to rest. The importance of this point will be made plain presently.

Meteoric iron when sawed through, polished, and etched with acid, shows a distinctive crystalline structure which is known as Widmanstätten figures—first observed by A. B. Widmanstätten in 1808. These figures have been revealed by the meteoric-iron bodies found in and around Meteor Crater; and they thus register the facts that the bodies came from the sky and that after they reached the earth they were never heated internally higher than 1,472° F., (800° C.), because at that temperature the figures would have disappeared for all time. Similar figures have also been found in the oxidized envelopes or remains of many of the meteoric-iron bodies gathered on and in the rim of the crater or about it within a radius of five miles. None has been found farther than this from the crater; and they increase in abundance as the crater is approached.

Typical shale balls with centers of nickel iron. The right and the left specimens have been sawed in two and etched with acid to bring out the Widmanstatten figures.

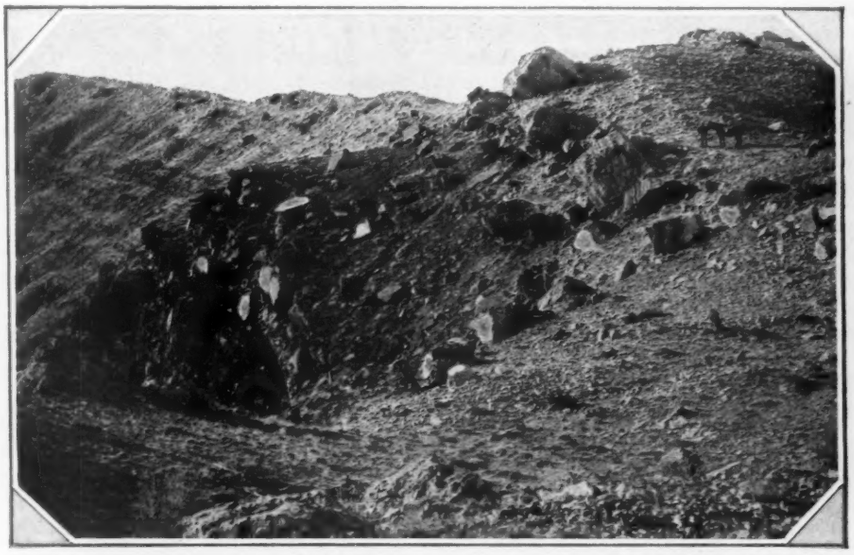


Irregular masses of nickel-iron shale, from the plain around the crater, indicating how the shale-ball meteorites were decomposed by long exposure.

Many of these bodies that fell on the surface of the plain around the crater have been oxidized by long exposure to the actions of air and water. Where they have been protected by being buried in ejected rock fragments, their original shape has been preserved; and they have been given the name of "shale balls" because of their peculiar structural character. The survival of the Widmanstätten figures proves the origin of these masses, as do the facts that unoxidized metallic meteoric-iron is often found within them and that they contain, when oxidized, the relative proportions of iron and nickel—taking into account the presence of oxygen.

The curious-minded will naturally ask: "Why, if thousands of meteorites hit the desert without making lasting impressions, should any of them have possessed sufficient pent-up energy to dig the crater and to bury

themselves at a depth of more than 1,200 feet below the normal level of the plain after traversing solid rock?" The answer to this is, that the vast excavation was made by the impacting force exerted by the enormously weighty nucleus or head of the comet, composed, probably, of many thousands of metallic-iron bodies acting, so to speak, like a bunched charge of shot fired at a board from a choke-bore shotgun at short range—the board in this case being massive strata of limestone and sandstone. Even with this explanation, it is difficult to conceive a force great enough to dig such a hole in solid rock and to shatter and even to pulverize many millions of tons of sandstone to a fineness that will permit about 60 per cent of it to pass through a wire screen of 200 meshes to the inch. The "rock flour", as it is called, looks and feels not unlike talcum powder. A steam explosion could not possibly have produced such an effect.

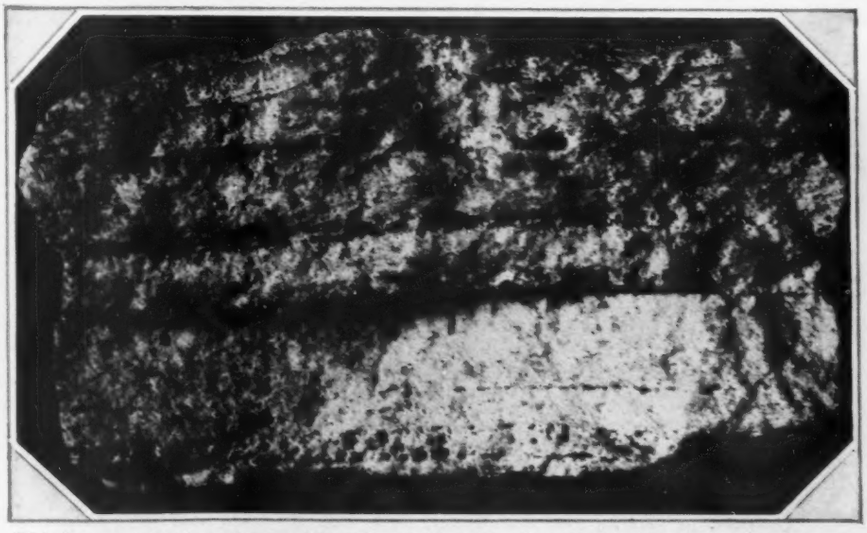


A trip around the inner rim of the crater means a journey nearly 2½ miles long, and much of it is rough going.

One of the most interesting of the effects of the impact was the formation of two previously unknown varieties of metamorphosed sandstone. One variety apparently is due to the effect of the waves of concussion which passed through the sandstone immediately before the force of the impact tore the stone to pieces and threw out the fragments. Those portions of the white sandstone affected in this way show evidence of enormous pressure which, besides shattering the individual sand grains, compressed them so as to produce a slaty or schistose structure. All this happened in the inconceivably short time which elapsed before the sandstone was thrown out in fragments. In these specimens virtually all the minute grains of sand are seen to have been shattered; and by reason of the compression to which it was subjected, a piece of this altered sandstone seems to be heavier than the original sandstone from which it was produced.

This tumultuous heap of large pieces of shattered rock has been named Barringer Point and marks the highest elevation on the crater's rim.

The second variety of metamorphosed sandstone is even more remarkable, for heat has manifestly played a great part in its changed state. There is no other instance in nature of quartz—and this very pure white sandstone is composed well-nigh entirely of minute grains of quartz—being fused, in the absence of a flux, except by the action of lightning striking sand or a mountain top. Science has named this product fulgurite glass. At the crater there are many wonderful specimens of sandstone seemingly so fused. In some cases the quartz is fused into lumps of opalescent material, but more frequently the sandstone has been puffed up and distorted, owing to the steam produced by the water which was in the stone at the time the outer and very highly heated part of the advancing meteoric mass was in close contact with the rock. Innumerable watertight cavities, as in pumice, were formed by the steam, so that large and small masses of this peculiar and most interesting sandstone will float like cork. Another proof that this variety of sandstone, unlike the contrasting variety, was very near the tremendously heated surface of the advancing celestial projectile, is that this altered sandstone is frequently more or less stained by vapors of iron and nickel. The heat that caused this trans-



This is a sample of one form of limestone altered by the effects of the impacting comet. It is so cellular that it will float like a piece of pumice.

formation of the rock was the consequence of friction induced by the comet's extraordinarily rapid passage through the sandstone. So far as is now known, similar specimens of altered sandstone have been found nowhere else; and, in themselves alone, they furnish incontrovertible proof of the meteoric origin of the crater.

Now let us return to the instant of the impact and to what followed almost at the same time—so brief being the interval between them. The rocky strata could not be compressed and pushed downward. Therefore, in order to effect penetration, the comet had to break up the rock, dislodge it, and throw it upward and outward. While the head of the meteoric mass was doing this work, that is, while the main mass of the comet was still excavating the crater, a shower of lesser members of the comet's train—slowed up in their descent or possibly stripped from the head of the nucleus by the resistance of the atmosphere—arrived and these later comers were buried beneath the outpouring of fragments and powdered rock cast around the great hole.

Well-nigh without exception, these smaller bodies of meteoric iron are found to be more or less globular or oval. They are the celestial cobblestones mentioned by Mr. Barringer. These meteorites are at present composed largely of iron oxide—their centers or cores alone being sometimes unaltered metal. This is the consequence of terrestrial oxidation. They have retained their approximately spherical shapes because they have been under cover—that is, buried in the finely ground rock flour, locally termed "silica"—and have not been exposed to the air and to the erosive blasts of the cloudbursts and the violent windstorms that sweep the Arizona desert from season to season. These meteoric specimens are the shale balls previously referred to, and they are decidedly different from the metallic-iron meteorites or siderites that have been picked up from the plain upon which they fell and were scattered concentrically about the crater. By finding these shale-ball meteorites at depths of from 20 to 30 feet in the material forming the crater's rim and admixed in no particular order with the rock fragments which were hurled from the bowels of the crater, Mr. Barringer was able to prove definitely by this fact alone that the meteorites fell out of the sky and that the crater was formed simultaneously. That is to say, the two events occurred at the same point and within the same second of time. Further evidence of the meteoric origin of the crater is not needed; but by his comprehensive work, Mr. Barringer has furnished many other proofs that are just as convincing. It is interesting to recall that more iron meteorites have been picked up and carried away from the area surrounding Meteor Crater than have so far been found on all the rest of the surface of the globe.

After much study and careful investigation, Mr. Barringer is now satisfied that the unoxidizable iron meteorites—known to the scientific world as Canyon Diablo meteorites or siderites—are merely the surviving unoxidizable nuclei of larger shale-ball, oxidizable, chlorine-bearing meteorites that have had their continually forming spherical coats of iron and nickel oxides stripped from them by the rains and the winds of ages. It is clear that both the siderites and the shale balls are survivals of compact clusters of similar meteorites that produced Meteor Crater. Accepting this as true, what became of the head of the comet that dug the crater? And where is it now? This brings us directly to the story of the work done at the crater since Mr. Barringer and Mr. Tilghman filed the mining claim, under the United States Mineral Land Laws, on the square mile containing Meteor Crater.

(*To be concluded*).

The date of the Pan-American Highway Congress, which is to be held this year at Rio de Janeiro, has been postponed from June to August.

STANDARD SPECIFICATIONS FOR DIESEL FUEL OIL

WITH the growing importance of the Diesel engine as a prime mover both on land and afloat, the efforts of the American Society of Mechanical Engineers to develop a satisfactory standard specification for Diesel fuel oil should be of interest to Diesel engine users and manufacturers, as well as to the companies providing the oil.

Heretofore there has never been a clear understanding on this subject between the manufacturers and the oil companies. The manufacturers were inclined to set rigid specifications for the fuel to be used in their engines, while the oil companies dispensed the products which they had in stock rather than supply a fuel that would meet the needs of the operators of Diesel engines. Since the formation by the American Society of Mechanical Engineers of the Special Research Committee on Diesel Fuel Oil Specifications, the desires, requirements, and limitations of both groups have been thoroughly discussed and closer coöperation between them reached. This, in itself, is an important step forward.

Another equally important achievement is the formulation of a standard nomenclature for use in determining Diesel fuel-oil specifications. Further reports by this committee are awaited with much interest.

The third and fourth reports made by the Gas Cylinders Research Committee of the Department of Scientific and Industrial Research, London, England, have been published by the Government Stationery Office. These reports deal, respectively, with light-weight cylinders for compressed gases and with cylinders for liquefiable gases.

In special cases, where light weight is a consideration, the committee recommends the use of small cylinders of nickel-chromium-molybdenum steel for the storage and transportation of "permanent" gases. For liquefiable gases, seamless carbon-steel tubes are endorsed.

This exhibit of the Canadian Ingersoll-Rand Company, Ltd., attracted much attention during the 1929 meeting of the Canadian Institute of Mining and Metallurgy, at Winnipeg, Manitoba. The display of rock drills and other essential mining equipment appealed strongly to the many practical mining men present.

Use of Air-Driven Equipment Increasing In Railroad Maintenance

By LAWRENCE A. LUTHER

THOMAS A. Edison is said to have said: "Were I to live my life over again, I would devote more time to research in connection with the uses of compressed air." Whether or not this eminent inventor made the foregoing statement, the fact remains that the applications of compressed air in the arts and the industries—large as the uses are—are relatively but little more than in their beginning.

The Hoosac Tunnel, started in 1854, was the first large undertaking of its kind on which compressed air was utilized; and work had been in hand on that great task twelve years before pneumatic rock drills were tried. We should have a striking contrast, were we able to compare the drills and air compressors employed then with the modern equipment used in the last few years in driving the Moffat and Cascade tunnels. The savings, based upon the work done, were tremendous in the cases of the latter jobs; and these favorable results were undoubtedly attributable in a very large degree to the progress made in perfecting air compressors and air-driven rock drills. An old drill runner of the Hoosac Tunnel days would be amazed if handed a modern rock drill. One of these splendid machines will "hog out" a hole in the hardest ground at a rate of more than a foot a minute. It would all seem to him as though black magic had been combined with the motive air—recalling as he readily would that the first air-driven rock drills were only a short step ahead of their steam-driven predecessors.

The continual improvement made during the past decade in the grade and curvature of our railroads has been measurably helped by the better rock-handling equipment available. It is much less expensive to ease a curve or to deepen a cut now than it was a few years ago because air-driven drills or tools

The pneumatic spike puller does its work fast and well and contributes to substantial economies in maintenance-of-way operations.

are doing their outstanding part in carrying forward work of this nature.

Notwithstanding the improvements made in portable, electrically driven tools of various types, still we find nearly all railroad jobs being handled with air-driven tools. In the largest and most up-to-date railroad shops, one is astonished by the well-nigh universal use of pneumatic tools. Why is this so? Because these tools combine lightness, ruggedness, and simplicity of get-up—characteristics that make them especially suited to meet the rigorous requirements of railroad service.

Wherever air-driven equipment has proved itself best for heavy-duty service in railroad shops, it has been found doubly desirable where working conditions are still more trying. Tools designed for track work must be rugged, and that is what air-operated tools are. This is notably the case in those devised for use in laying rails. Under the most favorable conditions, the handling and the care given equipment employed on track and on general construction work are far from ideal. But as careless labor and more or less continual exposure to dirt and weather cannot be done away with, the tools must be built to meet those conditions.

Where air-driven wrenches are used in running up bolts on rails, the best means of regulating the torque is by controlling the air pressure. This obviates the utilization of clutches. There is a large demand for air-operated tools for bolting and unbolting work on rails; and drills are being developed that will be capable of exerting more power. These should be of considerable aid in removing the joints from old rails. More powerful wrenches will obviate to a large extent following up with hand wrenches; and a more powerful machine should make it practicable to bring the nuts to a final tension. Furthermore, the field of service of such a tool could probably be extended to the retightening of bolts in tracks. This should help materially in insuring an even expansion and contraction slippage in rail joints due to temperature changes.

The pneumatic spike driver has proved a notable success. The straighter driving of the spike—combined with maximum holding power and minimum damage to wood fiber—has made a marked impression. The spike driver has also brought about considerable economies.

The use of the air-operated spike puller decidedly reduces the labor quota and effects other gains. Besides these savings there are performance characteristics which recommend this device. The normal action of the pneumatic spike puller is to draw the spike straight up and thus to avoid any unnecessary ream-

Tie-tamper compressor supplying air to four rail-bonding drills being used simultaneously.

Rail-laying can now be done speedily and satisfactorily because of the air-driven spike driver.

Four pneumatic tampers drawing air from a single compressor.

ing and tearing of the surrounding wood fiber. A comparison between a like number of holes of spikes drawn by machine and with claw bars presents an interesting study. From all this it would appear that "spike killing" might be measurably retarded by the combined use over a period of years of the pneumatic driver and the pneumatic puller.

The air-operated rail drill is perhaps the least conspicuous but nevertheless one of the handiest and most efficient pieces in a pneumatic maintenance-of-way outfit. Wherever compressed air is available on a rail job, this drill may be seen doing essential work.

The status in tie-tamping has changed materially during the past decade; and this matter well deserves a fair measure of study. Undoubtedly much more interest would develop in the subject if it were possible to indicate graphically the monetary benefits derivable from the use of the pneumatic tamper. Take, for instance, the conservation of timber and ballast. The portions of the ties and of the ballast which actually do the work of carrying traffic are the least accessible for inspection. Inasmuch as we cannot watch the bearing of a tie on its foundation as we can the bearing of a bridge member, we must rely upon other signs; and it is now commonly believed that the life of ties may be gaged with reasonable accuracy by the condition of the supporting foundation.

The damaging effect on ties of unevenly tamped ballast does not become apparent until after the lapse of considerable time. How many of us have noted the quantity of timber shredded away annually by pick and bar when they are used for tamping? The actual figures would, in some cases, be both astonishing and disheartening. Of course, when ties are treated, the consequences are not as serious as when untreated wood is exposed to the chipping and cutting action of hand tools. It is always difficult to fix the point at which the destruction of the ballast by pick-tamping leaves off and normal deterioration under traffic begins. If we note the pulverizing done by a few and exceedingly hard blows delivered by picks on the softer ballasts, such as limestone, we have some measure of their effect on any ballast. We must have blows to do tamping effectually; but a rapid succession of light blows with a pneumatic tamper will do the work with little pulverizing.

The dividends received from any investment in working equipment are limited to a certain extent by the amount of service which it is possible to obtain from each machine during a given period—a year, for instance. The use of some equipment is necessarily seasonal, while other units are kept more or less busy throughout the entire year—being adaptable for a wide variety of work. Portable air compressors properly come within the latter classification. Their field of usefulness, the list of tools that they can operate, is continually growing.

Pneumatic equipment may be ingeniously fitted into even a hastily arranged program. For example, two small compressors had just been purchased by a western road for tie-tamping when a fire destroyed half a mile of trestle over nearby river flats. Nearly every bridge gang between Albuquerque and San Francisco was concentrated on getting the main line restored to service. Old piling was cut off even with the ground, and upon them were placed framed bents. Someone suggested that air-driven boring machines be used for certain of the work and that the tie-tamper compressors provide the necessary air. Those machines paid for themselves in time and labor saved on that one job.

Compressors again proved their adaptability when they helped to build a "shoo-fly" around a tunnel in which the timbering had been destroyed by fire. The shipping and the placing of a suitable steam-driven compressor would have entailed a serious loss of time and have been a tedious job. From a San Francisco warehouse a battery of portable machines was promptly shipped in baggage cars. Six of those compressors worked continuously, day and night, for several days in supplying air to rock drills. While most tasks to which portable air power is applied are planned more deliberately, still we see it is the capacity to do "pinch hitting", when the demand suddenly arises, that emphasizes some of the virtues of these mobile power plants.

Many jobs requiring compressed air are of relatively short duration. Railroads that long made it a practice to "spur out" heavy steam-driven equipment now find it advantageous to utilize portable units instead. The undertakings that have been speeded along by portable pneumatic equipment and on which that equipment has demonstrated its economy are too numerous to mention here; but the next time you are faced with a difficult and perhaps unexpected task just see if compressed air can't be of help to you.

Tie-tamper air compressor furnishing air for tools used in bridge repair work.

What is claimed to be the most important petroleum refinery in Europe was completed not long ago at the entrance to the Port of Rouen, France.

Spray-Painting Great Quebec Bridge Saves Much Time and Money

THE City of Quebec stands today as a glorious monument to the courage of the pioneers who established there the stronghold of New France; and the city glories equally because of what she has come to be through the domination of the British who succeeded to that beautiful seat of power in the New World—courage again winning the right to hold sway there. The people of modern Quebec have indubitably a double birthright of courage because of the commingling of two sturdy national strains; and they have exemplified this heritage in numerous ways, and perhaps in no more spectacular manner than in the spirit shown by them in spanning the St. Lawrence River with a monumental bridge.

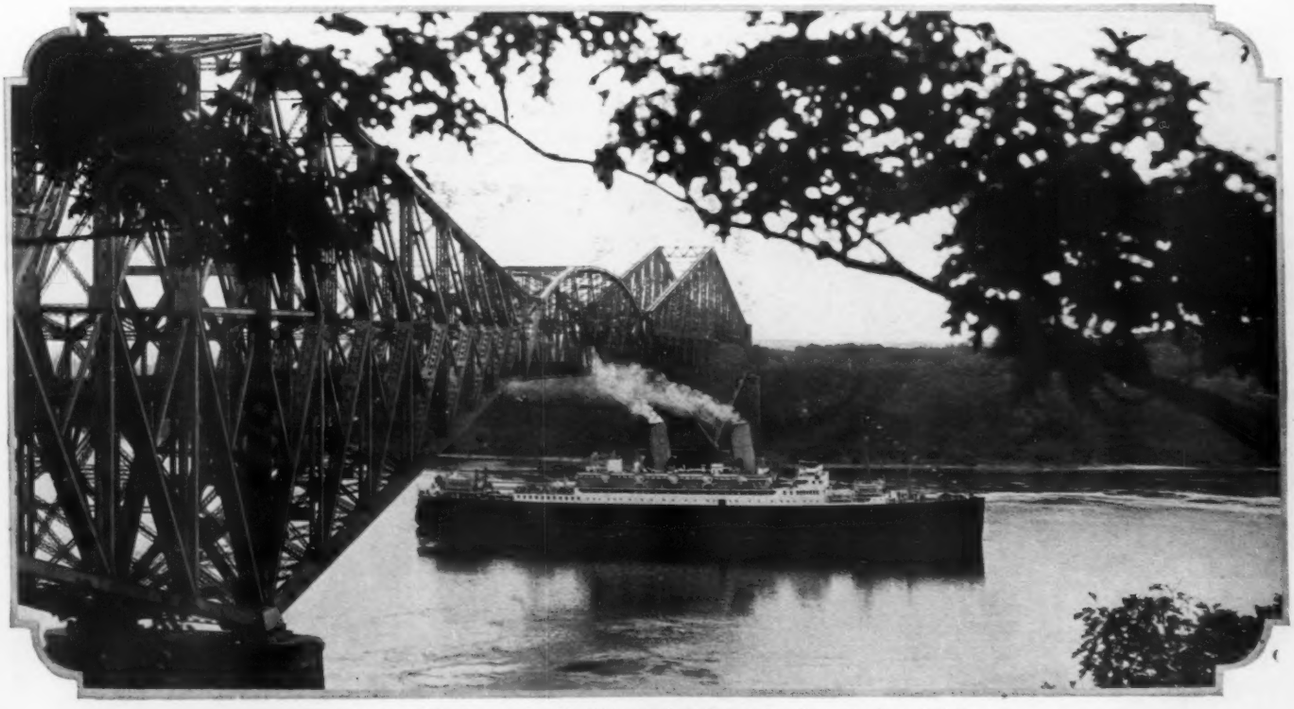
We need not dwell upon the causes that wrecked the first structure in 1907 nor the catastrophe of 1916, when the center span of the second bridge fell just as that closing member was being hoisted into position. The point of present interest is that the present structure was undertaken despite the appalling collapse of the earlier bridge; and scarcely had the news of the failure of the center span of the second bridge been placed upon the wires than orders were issued for the building of a replacement member—ample evidence of the courage of the people determined to span the river at the point chosen, and equal evidence of their faith in the ability of the appointed engineers to make good.

The Quebec Bridge required about five years for fabricating and erecting; and the first train to pass over it did so on October 17, 1917. On December 3 of that year the structure was handed over to the authorities for regular train service. Since then the bridge has performed perfectly the extremely important function of communication for which it was reared at an outlay of $25,000,000. The bridge, undoubtedly, is one of the really notable engineering wonders of the world; and over it the Canadian National runs its trains that travel between Montreal and Quebec. It is said to be the largest cantilever bridge in service today, and has the longest and the heaviest span. The bridge is 2,830 feet long; and its center span, from pier to pier, has a length of 1,800 feet. The center section, which was hoisted into place bodily, has a length of 640 feet; and there is a clearway of 150 feet at high tide between the surface of the river and the underside of the structure. It is beneath this center span that all ocean liners pass in plying between Montreal and foreign ports. The bridge has two railway tracks laid 32½ feet center to center; and outside of each track there is a 5-foot concrete sidewalk. The total quantity of steel used in the structure amounts to 66,480 tons; and the strength of the bridge is such as to insure an ample margin of safety when the largest of locomotives—weighing 655,040 pounds—hauls over it a heavy train.

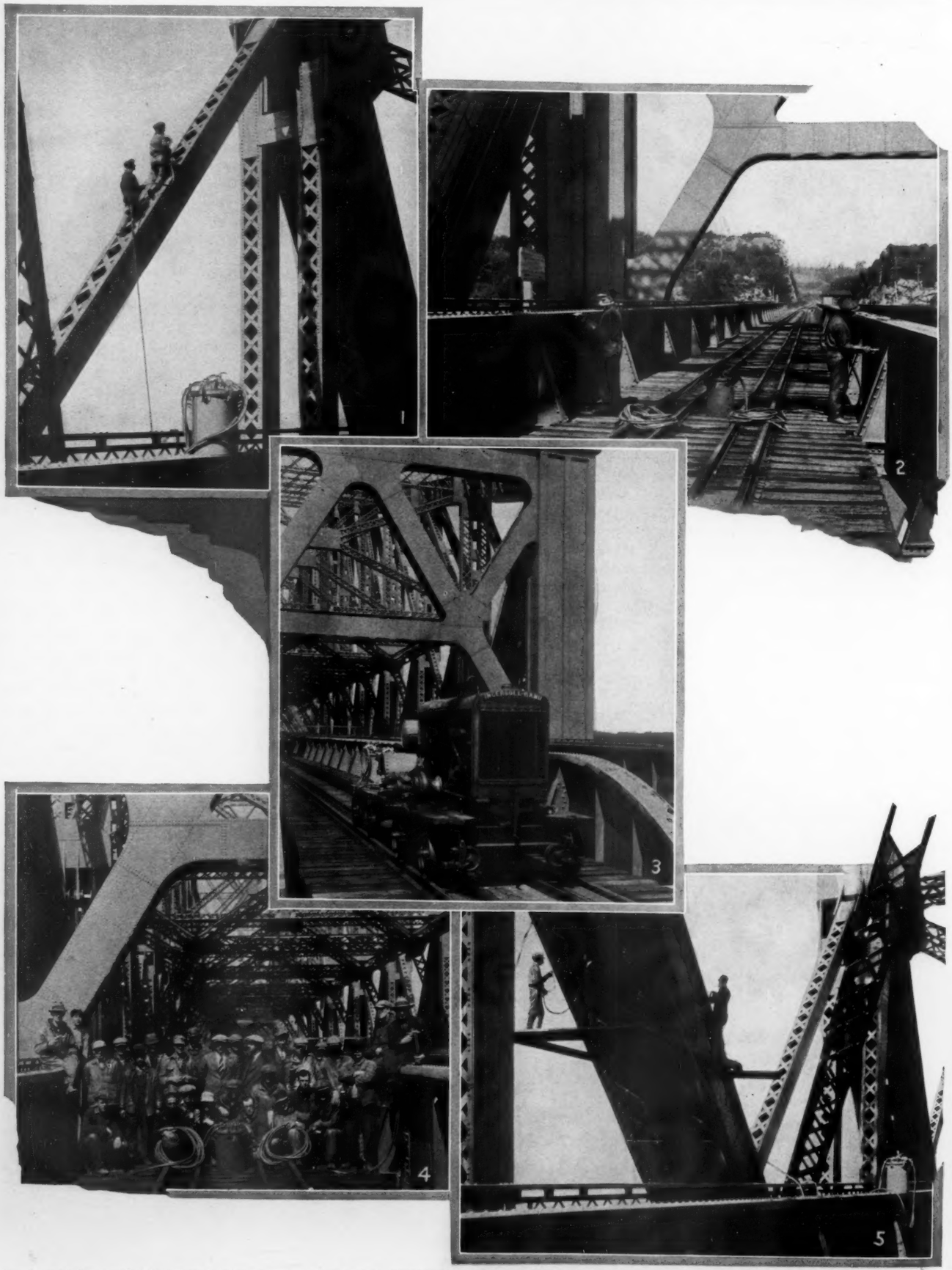
So much for the history and the engineering characteristics of this magnificent bridge. Now let us touch upon another phase of the matter—that is, the proper maintenance of all that interrelated maze of steelwork so that the corroding action of the atmosphere shall not attack the metal and impair its physical soundness. Probably the slogan, "Save the Surface, and You Save All", has no more fitting application than in the case of a bridge exposed to all sorts of weather and to wide ranges of temperature. The thorough and systematic painting of the Quebec Bridge is indispensable to its proper upkeep; and the public at large might reasonably wonder how this work is done. We are indebted to the *Canadian National Railways Magazine* for the following particulars:

"Painting involves many problems, for the bridge is exposed to an extreme temperature range—90° F. maximum and 31° below zero minimum. The surrounding atmosphere is frequently moist and foggy, and dew sometimes remains on the steelwork until 11 o'clock in the forenoon, which means that the work of the painting crew must be arranged accordingly. Painting the bridge also involves problems in spray-painting seldom experienced elsewhere, for the men must work sometimes from 200 to 300 feet above the level of the water, and, also, always in a high wind.

"Apart from the 7,500 gallons of paint used to give the bridge a single coating, it might be added that 70 gallons are needed to cover once each of the four main posts, or 280 gallons in all for the posts alone. Further, to apply a single coat of paint to the entire structure necessitates the united efforts of 35 men, working steadily from June 15 to Sep-



The S. S. "Duchess of Atholl" passing beneath the Quebec Bridge.



1—A painter and his helper high up on the great Quebec Bridge. 2—Spray-painting guard rails. 3—This Ingersoll-Rand 7x6-inch portable compressor car, equipped with a utility hoist, furnishes the air used in spray-painting. 4—Mr. Louis C. Dupuis, Divisional Engineer, and his men who painted the bridge. 5—The painters' scaffold and the paint-gun tanks are handled by the utility hoist on the compressor.

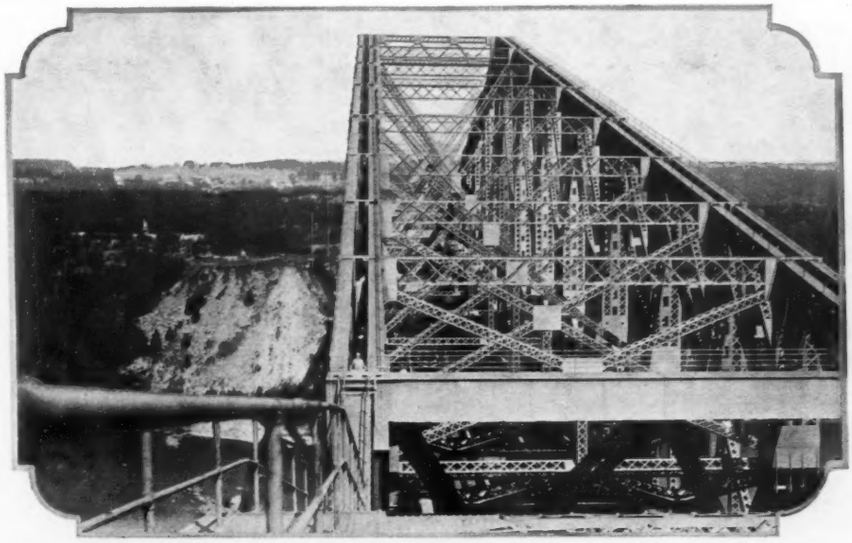
tember 15 each year over a 3-year period. The bridge, at the same time, is inspected and the movable parts greased and oiled.

"Formerly, the paint was applied by a brush-painting gang of eighteen men. Then spray-gun equipment was introduced and more men were employed, and the work each season was doubled in quantity and vastly improved in quality. The equipment used includes spray guns of the latest design, a heavy-duty gasoline-driven air compressor, air-operated winch, and pressure-type paint containers. Five 2-man, 14-gallon, pressure outfits are used to supply the ten sprayers, and each sprayer has a helper to assist him in his work. The gang includes, besides sprayers, sprayer helpers, scaffold handlers, a blacksmith, and a boatman. The boatman stays under the bridge when the painters are at work to rescue any one who might accidentally fall into the river.

"Since the introduction of spray-gun equipment, the cost of painting the bridge each year has steadily decreased. In 1927, when the spray-painting method was introduced after about one-quarter of the work had been done by brush-painting, it cost slightly over $7 per gallon of paint applied. In 1928, that figure was cut to a few cents over $5 per gallon, and further reductions are anticipated in 1929. These figures include material, labor, and equipment maintenance in connection with the painting job."

Manifestly, the use of the newer method has brought about marked economies in this phase of upkeep. Putting the total saving in 1928 at approximately $15,000, that sum is enough to cover several times over the entire outlay for equipment. The work was initiated by Charles P. Disney, Chief Bridge Engineer, Central Region, Canadian National Railways, and has been carried out under the personal supervision of Louis C. Dupuis, Divisional Engineer of the same system.

Canadians imported commodities to the value of $82.50 per capita from the United States in 1928.



This gives a good idea of the complexity of the steelwork and the character of the surfaces that must be painted to protect them from the corrosive action of the atmosphere and the weather.

LIGHT-SENSITIVE CELLS IN NEW SERVICE

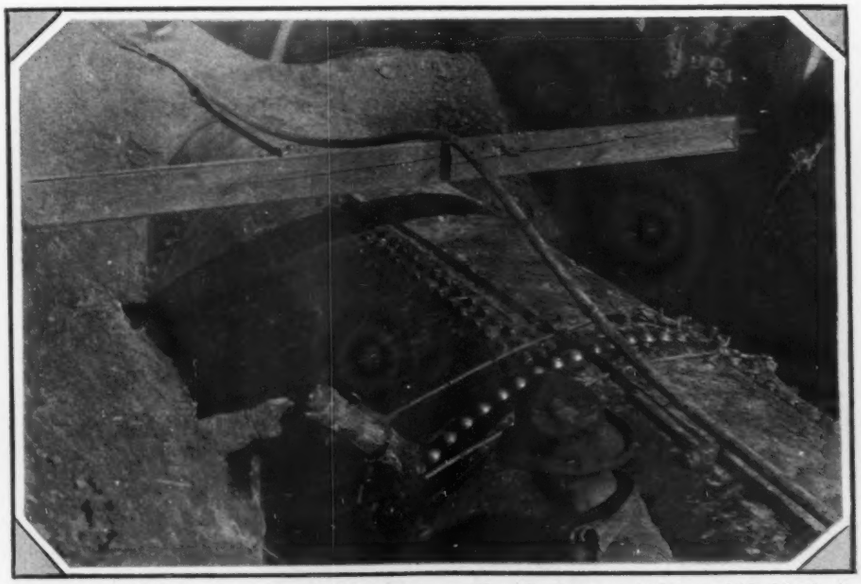
PHOTO-ELECTRIC and selenium cells are finding increasing use in industry for operating alarms and automatic controls regulating the level of liquids in tanks and standpipes. The following interesting example of an application of this kind is from *Nature*, and is in service at the Billingham works of the Synthetic Ammonia & Nitrates, Ltd.

A glass inspection gage is fitted at the required level on a standpipe, and the light-sensitive relay is illuminated through the gage. In the case of opaque liquids, the light is shut off when the liquid rises—the relay then operating an alarm signal. When the liquids are transparent, an opaque float in the gage glass effectually prevents the light from reaching the relay at the proper moment.

On the other hand, when flat gage glass, to which a right-angle prism has been cemented, is used, then the light-sensitive relay and the light source may be mounted on the same side of the gage glass. Under those circumstances the relay is illuminated by a reflected beam of light until the liquid rises, when the beam is refracted through the liquid. This system of regulating the level of liquids is said to be especially applicable to liquids under high pressure, because they cannot be controlled by the available standard methods.

GUIDEWAYS AID IN RIVETING PIPING

BY welding a piece of metal strap about the front end of a combination holder-on and rivet hammer in such a way that it would project a couple of inches at each side, and by further welding a 2-inch nut to the end of each projection, the Thompson Manufacturing Company, of Denver, Colo., was able to speed up the riveting of a steel water pipe. Two wire cables were passed through the nuts and hooked about the pipe, enabling the gun to be moved from rivet to rivet without delay and without loosening the tension cables. A trench was excavated beneath each joint to allow the riveter access to the underside. Air pressure was furnished by an Ingersoll-Rand portable compressor, and was distributed through a pipe laid alongside the excavation.



By means of this arrangement of guideways the riveter was able to shift his tool from point to point with ease.

A new cathode-ray tube that is so fragile that a draft of air will bend it has been produced by Dr. C. M. Slack, who is a member of the Westinghouse Electric and Manufacturing Company research staff. It is only half as thick as a piece of cigarette paper, yet strong enough to seal a vacuum against atmospheric pressure. Doctor Slack says the purpose of the new tube is to study the unknown effects of cathode rays and to produce rubber and nitrogen compounds.

Moisture in Compressed Air and How It Can Be Removed

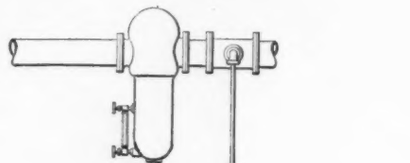
By A. C. DELFIELD

IN nearly all uses of compressed air there is usually more or less trouble from water that condenses in the lines when the air cools off after compression. The use of an aftercooler near the compressor will remove most of the water; but there is usually some further cooling of the air as it passes through the lines. This condenses more water, which will show up at the outlets where the tools or other air-using appliances are connected.

Water slows down the operation of tools, washes out the lubricating oil, causes sticking and rusting of valves and other small parts, and carries along an accumulation of rust, pipe scale, and other gritty materials which make for rapid deterioration of the tools. We often hear the erroneous statement that air freezes in the exhaust of drills, motors, etc. The air does not freeze: it is the water carried with the air that forms ice and sometimes renders the tools inoperative. In sand-blasting, a little water coming with the air dampens the sand, causing it to cake and choke the sand feed so that the machine is "air-blasting" part of the time instead of sand-blasting. In air-brush painting, or in applying enamel or other vitreous coatings, a drop of water will leave a spot that will spoil an otherwise perfect job.

The quantity of water is not great, especially if aftercoolers are used; but the resulting nuisance and delay are entirely out of proportion to the volume of that water. One often sees laborers shut off their tools and disconnect them to "blow out" the hose. This gives only temporary relief, and entails a considerable loss of time and air. Drip pockets located in the line will catch most of the water; but they have to be drained at frequent intervals, and this introduces the unreliable human element. Any good form of steam separator will also work on air, but such a device serves merely to accumulate the water and does not finally dispose of it. A steam trap can be connected to the separator, although most steam traps do not work well on air.

An operating engineer has contributed to *Power* one possible solution which, while no doubt effective, has certain drawbacks. To quote: "In a plant furnishing compressed air for various processes of manufacturing, a great deal of complaint was occasioned by moisture in the air, especially during damp weather. A separator 'helped some', but there was difficulty in trapping the water from the separator, and it was necessary to leave a small drip or bleeder open all the time, as the trap did not work right. Consequently, there was considerable loss of air at times, and at other times the water would accumulate faster than the bleeder could take care of it. The difficulty with the trap was caused by its becoming air-bound, so the engineer drilled, tapped, and connected it—as shown in the illustration—with the air main, allowing the air to flow back to the main. No further difficulty was experienced."



Courtesy, Power

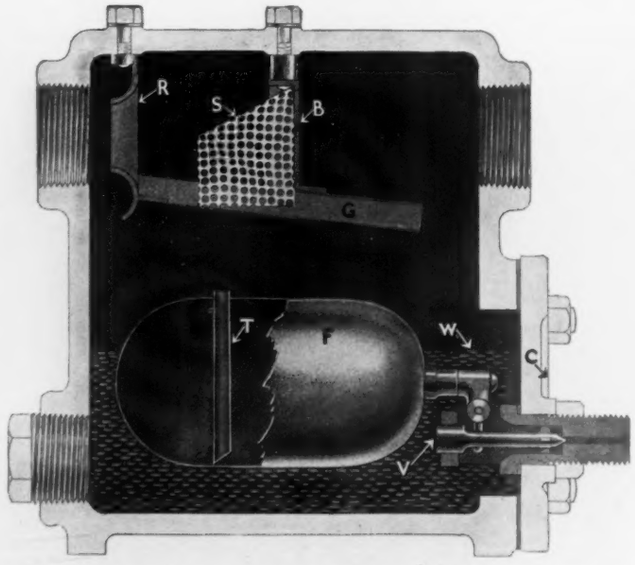
This trap was devised to meet conditions in a certain plant.

Fortunately for the users of compressed air, the water nuisance may be eliminated automatically by a combined separator and trap that separates the water and discharges it, as fast as it collects, without any human attention. This unit, which is interposed in the line close to the outlet end where the air is taken for use, will deliver compressed air that is dry and free from pipe scale, gritty material, etc. No attention is required after its installation.

In one of these devices now available, wet air enters at the left and meets ring baffle R, as shown in the accompanying sectional cut. This baffle deflects the heavy slugs of water, which usually run along the inner surface of the pipe, and throws the water outward against the wall of the separator body and downward into the collecting space at the bottom. The air passing through the ring contacts with the sloping surface of the perforated baffle or screen S—the water passing through the perforations and into gutter G. If any water gets past the screen surface, it is caught in the flange or lip of center baffle B, which leads it into the gutter.

The surface of the water collected in the body is normally at about the level shown by water line W. If it should rise higher, the buoyancy of float F, operating through a simple bell-crank lever, opens valve V and lets out water until the normal level is again restored. As the valve is well below the water line it is effectually sealed so as to prevent any possible leakage of air.

The float used is of a type that cannot collapse, because the pressure within, admitted by equalizing tube T, is at all times equal to the pressure exerted against its outer walls, no matter how high that may be. Should the float leak for any reason it will automatically bail itself out. This is effected through slight reductions in the external pressure, such as occur continually in any pressure system, which tend to reverse the flow in the equalizing tube. The valve and the float mechanism can be removed as a unit by simply removing four nuts and taking off cover C, on which the unit is mounted.



Sectional drawing of a combined separator and trap that removes water from compressed-air lines and discharges it without human attention.

Not being satisfied with the speed of a boiler-tube cleaner, operating with water under a pressure of from 100 to 125 pounds, an engineer conceived the idea of utilizing high-pressure air in combination with the water. The result is entirely satisfactory, according to *Power*. The cleaner now runs much faster, doing its work in less time than formerly; and the water keeps the tool cool and washes the dirt out of the tubes.

A sum of $1,425,885, to be spent over a 3-year period, has been appropriated for the improvement of the Main Reef Road that connects all the towns on the Witwatersrand, South Africa's famous mining district.

Arizona Hotel Built of Concrete Blocks Tamped With Pneumatic Tools

By A. S. TAYLOR

"UNCLE Sam's Sun Parlor" is the somewhat picturesque way in which Phoenix, Ariz., has been described by an enthusiastic admirer. What has been said of the atmosphere of that up-and-doing city can be said with equal fitness of the whole of the adjacent territory; and it is with a particular part of this sun-bathed section that we are here concerned.

The purpose of this article is to tell how abundant sunshine and an agreeable temperature range are the promoting reasons for the building of a hotel, an associate group of cottages, and the creation of other pleasurable conveniences that will involve a total expenditure of substantially $3,500,000. The cottages are not what most of us would be inclined to designate by that term—their structural get-up and their general features being architecturally too pretentious for so modest a classification; but this, as will be seen presently, is just that much more warrant for treating the subject in our pages.

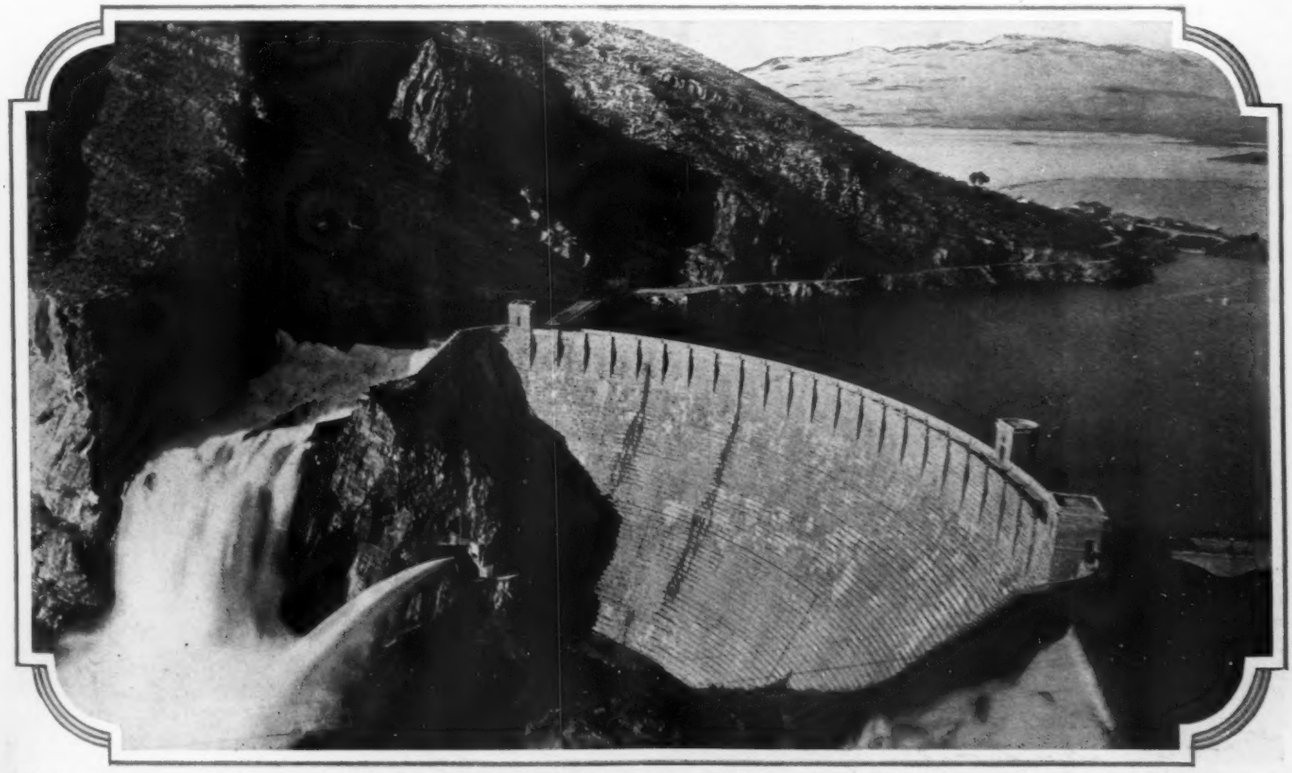
"You can play golf the whole winter through in your shirt sleeves!" That, in a few words, sums up the balminess of a winter in that part of Arizona, and tells how much less favored other sections of the United States are where furs and overcoats are the order of the day at that season of the year. And just because the health seeker and others of comfortable means can play golf in their shirt sleeves when Jack Frost grips so much of the rest of the nation is why the Arizona Biltmore Corporation decided to create a unique resort at the foot of Camelback Mountain, about ten miles outside of Phoenix.

"Why", you will ask, "is the Salt River Valley of Arizona so blessed?" The valley floor lies at an altitude of 1,100 feet. The air is remarkably dry; and the region is shielded from the sweep of cold winds by high mountains surrounding it on the north, east, and west, while a spur of low-lying hills intercepts any winds that might approach from the south. Indeed, some of the natives say that the winds are never more boisterous than brisk breezes; and generally the air movements are what are usually called "gentle". The Salt River Valley can boast a growing season of nearly 300 days a year; and roses bloom there every month of the year except August—and August, by the way, is the time when the seasoned resident goes elsewhere in quest of coolness.

A winter season in Arizona may be best likened to the opening period of an eastern spring. In November, the highest temperature will be around 78° and the lowest about 48° F.; December will be somewhat cooler—the high and low temperatures ranging between 63° and 39° F.; but during January, February, and March, the highest will run between 70° and 73° F. and the lowest between 42° and 47° F. Throughout a year, the sun shines on an average 84 per cent of the daylight hours. These figures make it understandable why the Salt River Valley of Arizona is becoming more and more a winter resort for persons seeking escape from harsher climates at that season.

Irrigation has converted an arid waste, with a beneficent climate, into what has quite appropriately been designated as "a man-made oasis". The valley is a veritable garden spot that is given over to general farming; the cultivation of citrus fruits; the growing of dates, cotton, lettuce, and melons; the raising of poultry; and to dairying. The markets of the countryside bear ample evidence to the productiveness of the soil and to the many good things that are cultivated in the region to tempt and to satisfy the palate. Where better to build a hotel and to create a somewhat exclusive community for the enjoyment of visitors that can afford to seek such an environment?

The Biltmore project includes the building of a hotel, capable of accommodating 375 guests, and the erection of fifteen cottages nearby. Upon the estate there has been con-



Picturesque Roosevelt Dam which has made it possible to impound more than 1,637,000 acre-feet of water and to distribute it during the dry season to agricultural lands that now bloom in the desert.

structed an 18-hole golf course. Further, a dam has been built across the mouth of a canyon in Squaw Peak rising behind the hotel; and water will be pumped into the impounded area to provide an attractive lake for storage purposes. The hotel site lies close to an irrigating canal that draws its water from the lake formed by Roosevelt Dam; and this waterway, with its flanking trees and bushes, adds just that much more to the picturesqueness of the setting. A year or two hence, the Biltmore estate will be verdant with waving palms and a wealth of floral beauty—all flourishing in a soil ready to produce when irrigation supplements the stimulating sunshine.

Apart from the lure of an exceptional climate, Arizona is a scenic wonderland; and the Biltmore estate lies within easy motoring distance of a wealth of physical charms and historical and prehistoric points of the utmost interest. So much for the things that Nature and the past have done to make this part of the country worth while to the visitor; and now let us see what it is that gives the Biltmore Hotel an engineering appeal to our readers.

Close-up of one of the special aluminum-alloy molds in which concrete "stones" are tamped with Ingersoll-Rand No. 14 air-driven sand rammers.

The architect, Albert Chase McArthur, in designing the hotel and the associate cottages, has striven to create an effect that will compliment the desert setting, and to this end is employing what appears to be decorated cut stone. As a matter of fact, however, it is man-made stone fashioned of well-tamped concrete molded in metal forms. All told, there are 29 different types of these "stones" or blocks; and in the erection of the hotel and the cottages fully 250,000 such blocks or units are required. The system employed in the making of them was invented by Frank Lloyd Wright; and it has been in use for a period of five or six years. Some of our photographs serve to give a good idea of the varied designs and the general nature of these concrete stones.

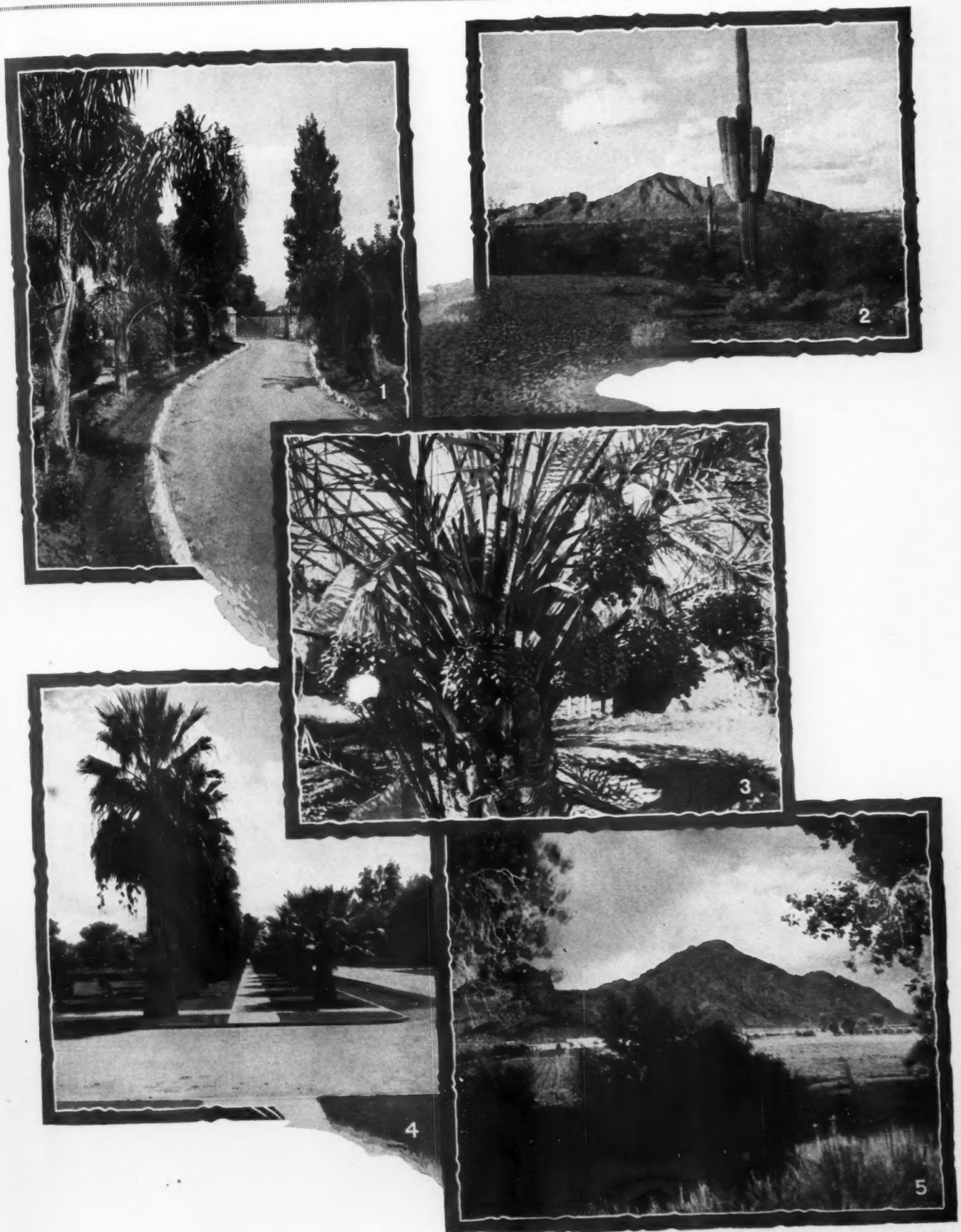
All the blocks are produced on the property and under a single shed where eighteen air-driven bench rammers of Ingersoll-Rand make are assembled in two working lines. The bench rammers are of a class known to the trade as No. 14; and in this case they are suspended and provided with counterweights in the form of bags of sand just heavy enough to hold the rammers out of the way when released by the workers. That is to say, but a slight effort on the part of an operator is necessary to pull a rammer down into the working position.

The concrete is composed of 3½ cubic feet of sand for each cubic foot of cement used and only just enough water is added to bind the mixture. In fact, the batch seems nearly dry when placed in the molds. The molds are patented affairs that are hinged and provided with locking features that enable the operators to close them quickly or to open them with equal ease in stripping them from the tamped blocks. The molds are constructed of an aluminum alloy which is strong and which makes them light and easy to handle. The material also safeguards the molds against rusting.

The procedure followed in forming a concrete block is very simple. The four sides of the mold are brought together and locked while resting on a suitable bedplate; and the concrete is then troweled into the mold and tamped firmly with one of the No. 14 sand rammers—the blows imparting a very compact texture to the block. When working at capacity, the plant in question can produce 3,000 blocks in the course of a working day.

Mr. H. E. Vaughan, in charge of the work, has kindly furnished the following particulars. After the blocks are removed from the molds they are set up under cover for curing. A period of five days is allowed for this. During the first day of curing the blocks are sprayed every 45 minutes; and from then on to the completion of the curing process the blocks are sprayed four or five times daily—this depending upon atmospheric humidity and the temperature. In Arizona, the governing factor is the prevailing heat. At the end of five days, the blocks can be set by the masons; but it is preferable to wait until the end of the week of curing. The curing curve during the first 30 days is a rather sharp one, but after that it is decidedly flat. In some of the building operations it has been necessary to cut the blocks for one reason or another, and the hardness of the artificial stone is evidenced by the fact that the stone masons say that structural limestone is easier to cut than the seasoned concrete blocks. Air to operate the sand rammers is being supplied by two portable compressors.

Two views of the batteries of sand rammers and aluminum-alloy molds that have been able to produce 3,000 concrete blocks in the course of a working day.

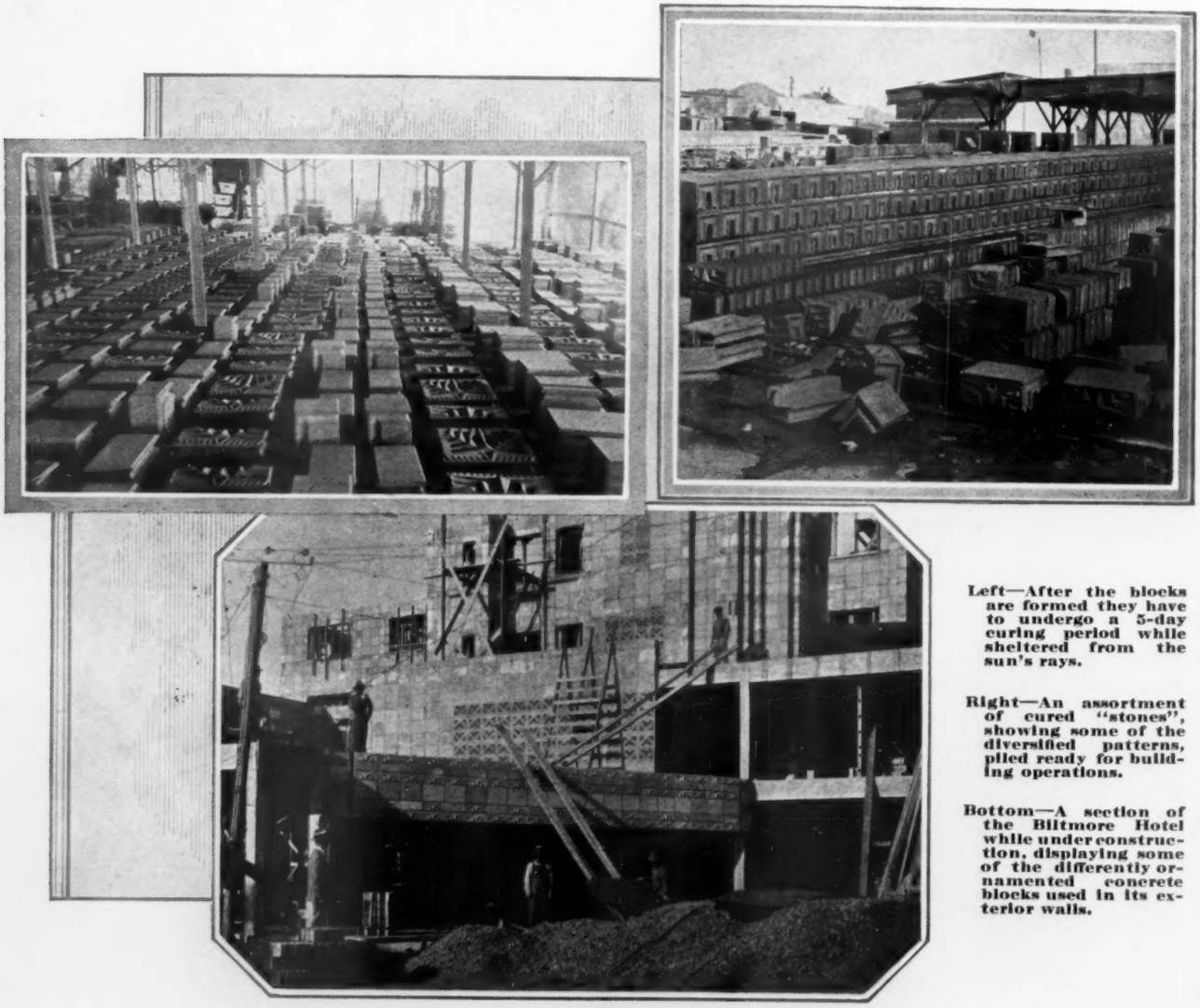


1—What irrigation does in transforming arid lands in the vicinity of Phoenix, Ariz. 2—Another characteristic glimpse of the countryside neighboring the Biltmore Hotel. 3—The cultivation of edible dates in Arizona is becoming a rapidly expanding and very profitable industry. 4—Nature's wealth of sunshine and man's skillful distribution of husbanded water have made this scene possible in a region normally a desert. 5—Camelback Mountain which lies just east of the property of the Arizona Biltmore Corporation. The water in the foreground flows in an irrigating canal.

Mr. Vaughan says that in earlier structures the concrete was hand tamped; and on the present job he employed one of his older workers who had never used a pneumatic tamper and who was very positive that the air-driven tool was unsuitable for the service. In order to get this conservative man properly started it was necessary to hide his hand tamper. It was not long before he was just as proficient with the pneumatic tool as anyone, and he was fair enough to praise the new equipment. Finally, one day when an air receiver went down and there was temporarily no air to drive the sand rammers, the old fellow was given his hand tamper and told to go ahead. He threw it down and walked away from the job and said he would come back only when he could use the pneumatic tool. He knew that he could do better work, more of it, and be far less fatigued when the day was done.

The concrete blocks are so designed that they provide annular spaces between the vertical and the horizontal contacting surfaces of contiguous blocks. Light reinforcing steel or strengthening rods are placed in these spaces, which are then filled with a rich binding grout that consolidates the associate units. As a consequence, the walls so constructed are given the desired full measure of strength.

The system is one that lends itself admirably to architectural purposes in erecting structures of various sorts, and is steadily gaining widening recognition. The use of concrete blocks is particularly desirable for buildings reared in those sections of the country where suitable natural stone is not readily available. Furthermore the simulated cut-stone block costs a great deal less to produce than stone carved and cut by hand.



Left—After the blocks are formed they have to undergo a 5-day curing period while sheltered from the sun's rays.

Right—An assortment of cured "stones", showing some of the diversified patterns, piled ready for building operations.

Bottom—A section of the Biltmore Hotel while under construction, displaying some of the differently ornamented concrete blocks used in its exterior walls.

PRESS PREPARES WASTE FOR JOURNAL BEARINGS

THAT trouble with hot bearings can be lessened by the use of properly saturated armature and journal-bearing waste is the experience of the Clifton Shop of the Staten Island Rapid Transit Railway, Staten Island, N. Y. This shop has rigged up a pneumatic press for forcing excess oil from the waste; and it attributes to this press the absence of hot bearings previously resulting from oversaturated waste.

The press consists of a 10-inch brake cylinder in which the usual pushrod and sleeve are replaced by a stuffing box and a solid piston, to which is secured a ½-inch plate. Beneath this plate is spotted a wire container placed in an iron tray with a drainage spout which feeds into the shop oil tank.

After it has been saturated in a temperature-controlled tank, the waste is freed of its excess oil in the improvised press—only enough being prepared at a time to meet requirements. Air to operate the piston is tapped from the main air line; and the work involves nothing more than filling the basket and turning on the air supply.

According to a survey made at the instigation of the United States Department of Commerce and the Department of State, there are under irrigation today throughout the world approximately 200,000,000 acres. This figure is but a fraction of the hundreds of millions of acres now lying unproductive for the want of water.

Building a Spectacular Mountain Road in California

This Motor Highway Forms Part of the Rim-of-the-World Drive in the San Bernardino Mountains

By S. G. ROBERTS

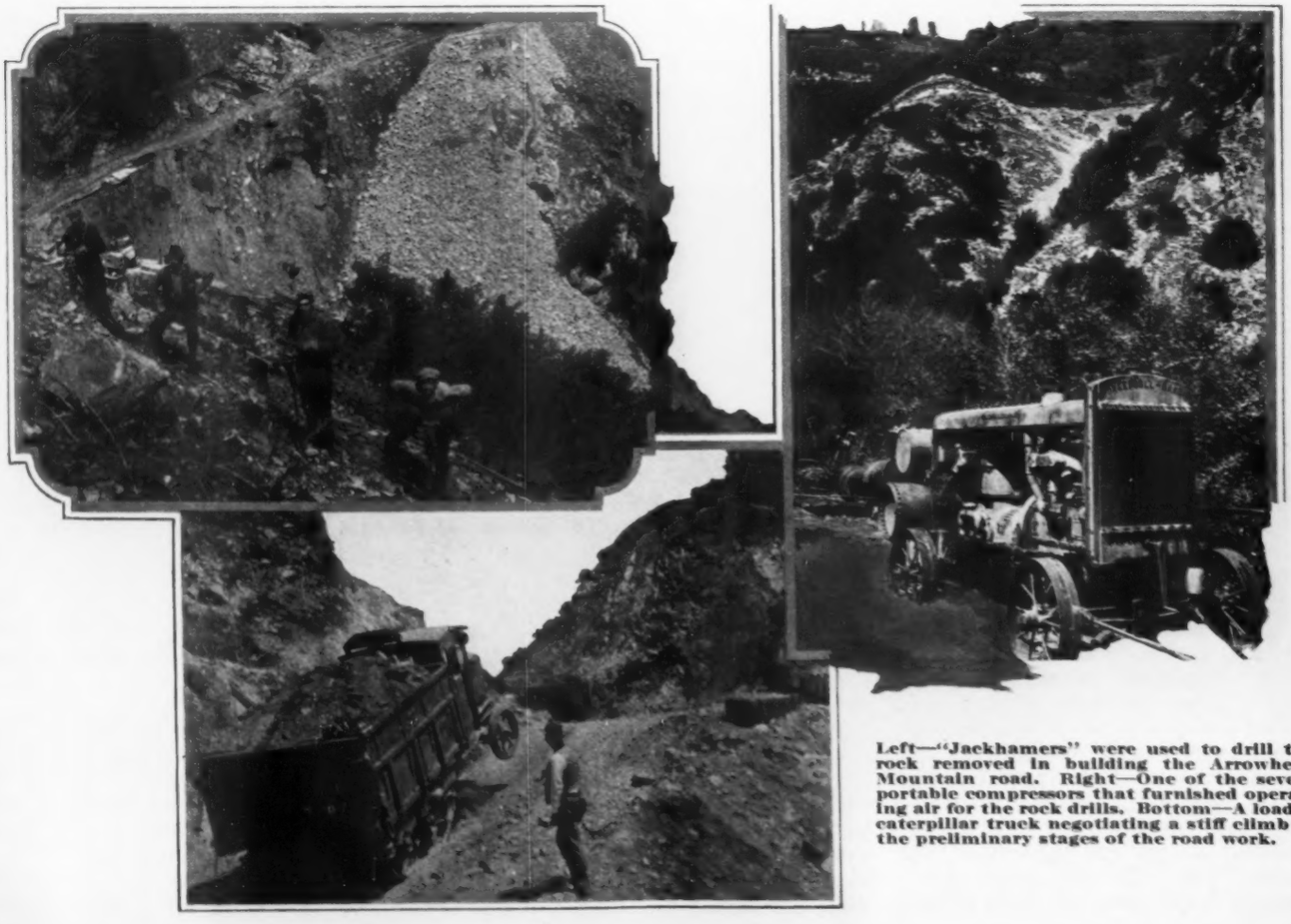
ARROWHEAD Mountain, Arrowhead Springs, and Lake Arrowhead—names that mean much to the Californian and awaken in him memories of lavish charms in a setting of much natural beauty—owe their appellations to a curious and spectacular mark that emblazons the steep face of Arrowhead Mountain.

Indian legend holds that the Great Spirit formed that symbol of the huntsman and the warrior, while the white man prosaically pronounces it merely a freak of Nature. However, be the origin what it may, still that gigantic emblem is unfailingly impressive, and, because of its size, visible for miles.

Somehow, a long, long while ago, an area of soil was deposited on the mountainside, and from that congenial soil sprang a growth of low light-colored bushes shaped like the traditional flint arrowhead. That growth still stands out in sharp contrast to the darker hue of the prevailing surrounding vegetation. From top to bottom the formation measures 1,350 feet; and it is not hard to understand why the superstitious aborigines held the region in religious awe. There is further justification for this attitude when it is recalled that the arrow points in the general direction of certain springs that have long been known to possess curative properties and away from the lovely lake that rests in a scenic setting high on the shoulder of the mountain.

Arrowhead Springs is nine miles to the north and east of San Bernardino and nearly 70 miles from Los Angeles. Years ago the spa was a fashionable retreat but then followed a period of decreasing appeal. Today, Arrowhead Springs is coming again into its own because of the medicinal virtues of its waters. Arrowhead Springs is in and near the entrance to Waterman Canyon; and it is through Waterman Canyon that the road runs that leads to the mountain top—to Lake Arrowhead, thence along the rest of the Rim-of-the-World Drive that covers a scenic circuit of 101 miles through the San Bernardino Mountains, and from there back to Los Angeles by the well-known Foothill and Valley boulevards.

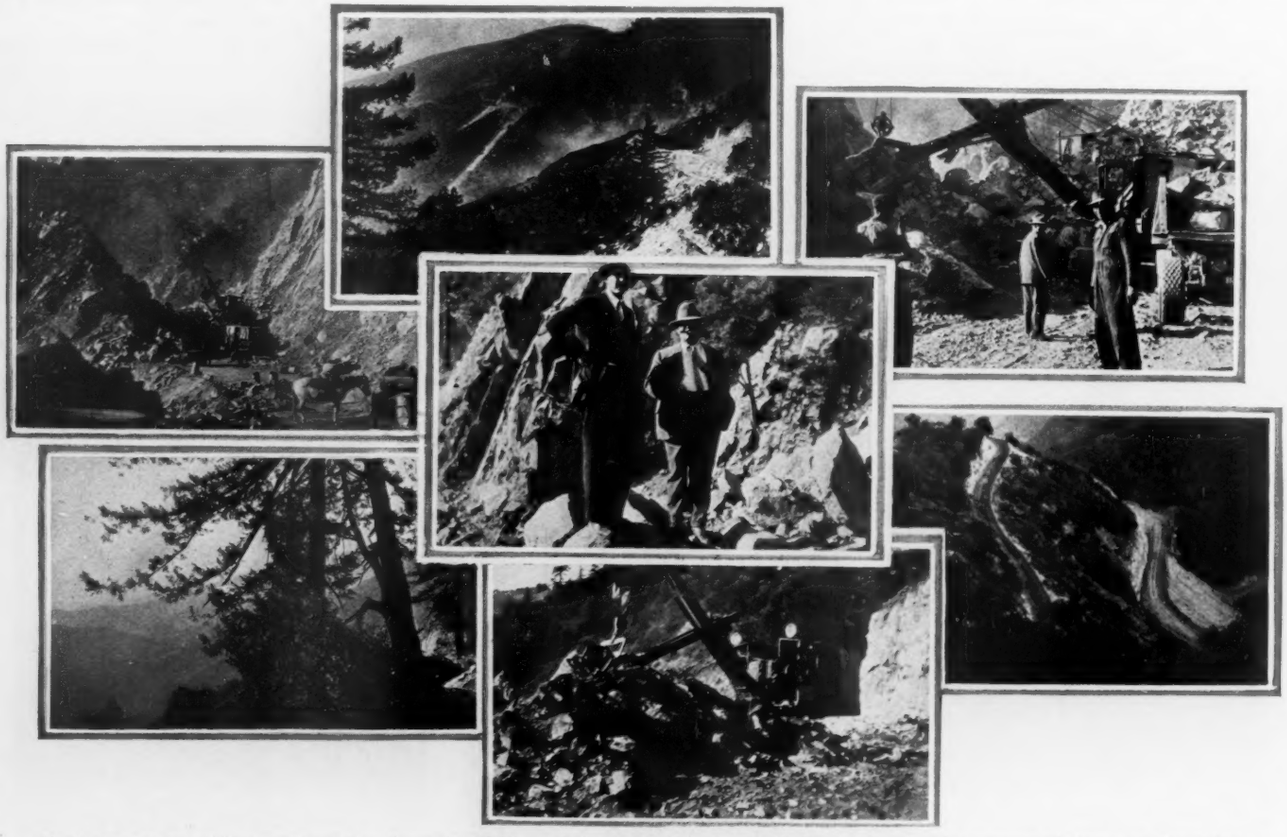
In order to reach the crest of Arrowhead Mountain, the motor road winds its steep and tortuous course for miles until the climb of 4,200 feet is achieved. There are frequent sharp hairpin curves to tax to the utmost the skill of the driver especially where there is an absence of guard rails and the edge of the road drops a sheer half thousand feet or more to the bottom of the neighboring valley. Despite its amazingly scenic outlook, the road has no joy for the driver; and it is apt to prove extremely dangerous when wet and the least bit slippery. There are many



Left—"Jackhamers" were used to drill the rock removed in building the Arrowhead Mountain road. Right—One of the severa portable compressors that furnished operating air for the rock drills. Bottom—A loaded caterpillar truck negotiating a stiff climb in the preliminary stages of the road work.

stretches that the average car can mount only in second. Whether mounting or descending, it is well to be sure that one's brakes are in proper condition.

The foregoing description has to do with the road that has heretofore been available to motorists bent on traversing the Rim-of-the-World Drive. Only a part of this road runs upon the south side of the range; and before the mile-high ridge is reached the route climbs along the northern slope of the mountain where the snow falls early and remains for months, during which some of the communities are isolated for weeks at a time. A new road has now been built—a road of much easier gradients—that keeps entirely to the southern side of Arrowhead Mountain where snow falls rarely and where the winter sunshine will keep the highway dry and passable most of the while. It is with the construction of this new road that we are to deal.



Various phases of the work on the Arrowhead Mountain road. Mr. C. M. Delin is seen in the center picture, at the right.

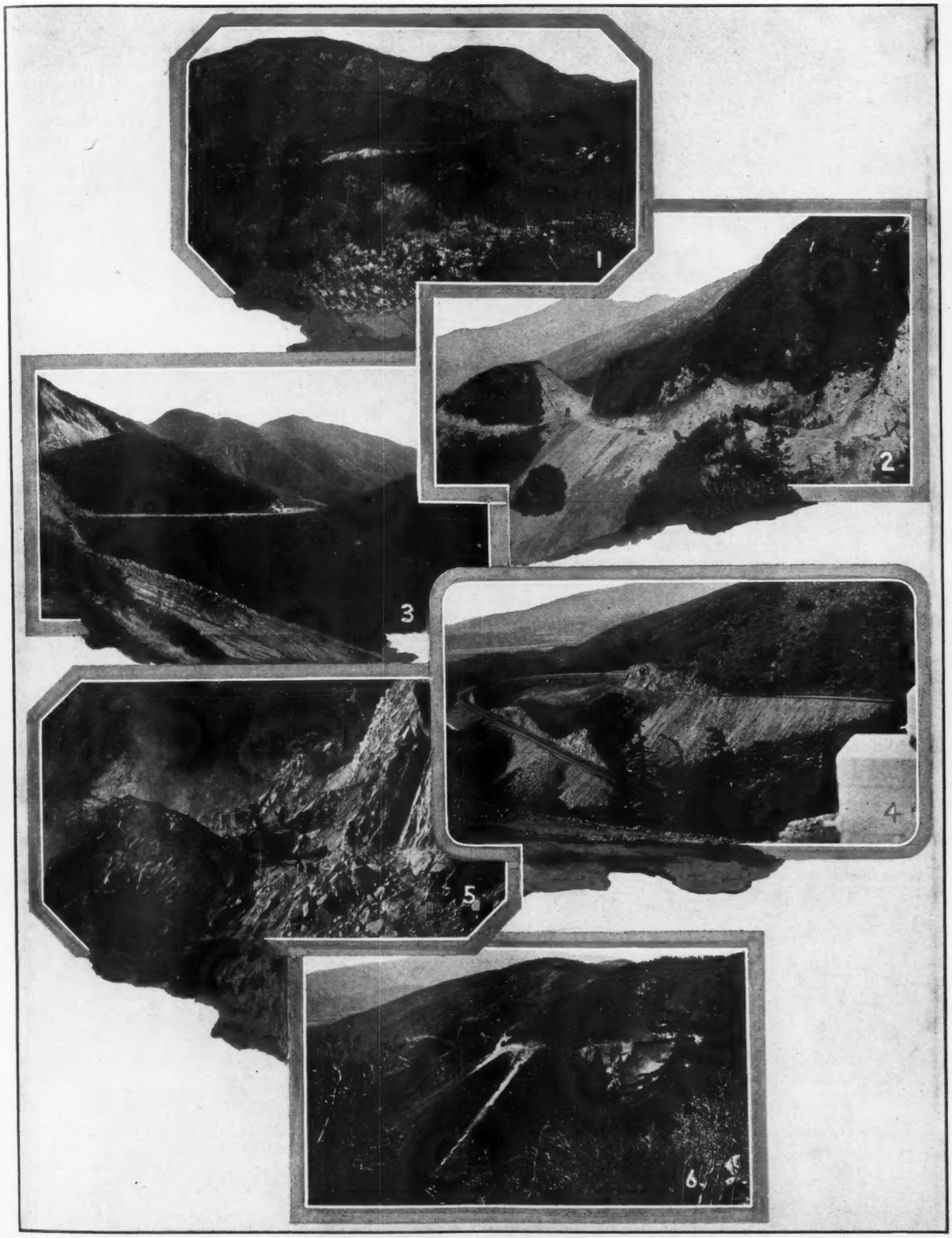
Before describing this undertaking and how the extremely difficult grading was handled, let us for a moment see why it is that the Californian, familiar with the Rim-of-the-World Drive, becomes instantly enthusiastic when the Arrowhead route is mentioned. From the crest of Arrowhead Mountain one looks southward over a valley laid out, as it were, in a checkerboard of orchards, vineyards, multicolored gardens, and attractive communities. For miles and miles the eye sweeps this southwestern expanse of San Bernardino County, a rich citrus belt, a wonderfully fruitful area that is in striking contrast to the far vaster desert region that lies on the other side of the mountains. From the road on the north side of the range, one's eyes sweep over a succession of rugged, forested mountains and valleys with the bald expanse of a desert plateau reaching onward and onward to the rim of the dim horizon. One must, indeed, be phlegmatic if he be unaffected, unstirred by the grandeur of the outlook from this vast up-heaved point of vantage.

Lake Arrowhead, which is the immediate objective of the new road, is a picturesque body of water that has been considerably increased in size by the rearing of a dam at its outlet end. The lake is surrounded by low, wooded hills, and is a vacation place that boasts year-round attractions. There, the well-to-do of Los Angeles and other lowland communities have built camps and cottages to which they retreat in the summertime. When the temperature is fairly high in the lowlands, Lake Arrowhead and the neighboring mountain top rejoice in a strong, cool breeze even though the sun may be shining undimmed. At such times the air is apt to be clear and delightfully balmy.

The road from Waterman Canyon up along the south face of Arrowhead Mountain has a present planned length of substantially 5¾ miles; and the magnitude of the task of grading the highway becomes evident when it is recognized that the work necessitated well-nigh 142,000 cubic yards of excavating per mile. The road was constructed under the United States Bureau of Public Roads and the California Highway Commission, and the work was divided into two contracts. The first section was let to J. G. Donovan & Son, of Los Angeles, and extends from Squirrel Inn, Squirrel-Inn Pass, for a distance of 3.54 miles—the contract price being $339,125. The second section, covering a stretch of 2.20 miles, was awarded the Nevada Contracting Company, of Fallon, Nev., for a sum of $285,281. This work was sublet to C. M. Delin, who has excavated a total of 260,000 cubic yards of rock.

The Donovan contract included the clearing of 33 acres and the excavating of 585,000 cubic yards of rock and earth—the rock ranging all the way from a hard decomposed granite to a solid-ledge formation. The contract of the Nevada Contracting Company entailed the clearing of 21 acres and the excavating of 412,473 cubic yards directly in connection with the roadway. Both Donovan and Delin were obliged to build temporary roads in order to reach their respective sections and to carry equipment and materials to points where operations could be pursued to advantage.

J. G. Donovan & Son located their camp a short distance downhill from the lower end of their contract; and their working force numbered about 75 men. When we realize that some of the cuts made in order to reach the prescribed grade are as deep as 120 feet on the high side, while others ranging from 40 to 60 feet in depth are fairly frequent, it



1—Arrowhead Mountain in the distance showing the peculiar formation, on the slope at the right, which is the reason for the mountain's name. 2—Section of Arrowhead Mountain road constructed by J. G. Donovan & Son. 3—A typical section of the mountain region traversed by the new road. 4—One of the hairpin curves linking sections of the mountain road. 5—A deep rock cut that has necessitated the removal of thousands of tons of material. 6—A distant view of that part of the new road built by C. M. Delin.

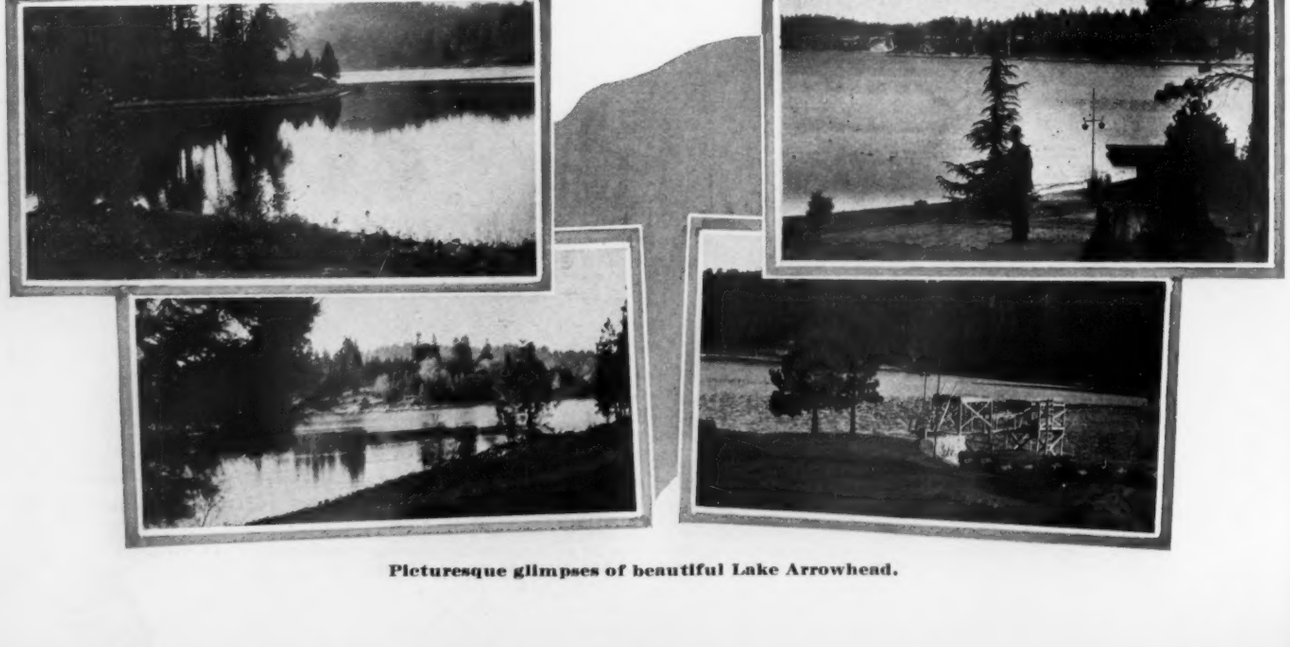
The Village of Lake Arrowhead and part of the new road while under construction.

should be plain that the task called for a great deal of excavating. The work could not have been carried forward with the dispatch it has but for the employment of power shovels, portable compressors, and air-driven rock drills. These modern mechanical aids enabled the relatively small force to drill, blast, and remove difficult rock and earth totaling nearly half a million cubic yards.

The Delin camp was situated at the upper end of the new road, fifteen miles from San Bernardino and seven miles from Lake Arrowhead. The point where the camp was located is an extremely beautiful one, overlooking as it does a tremendous area and including a wide expanse of the highly developed San Bernardino Valley. The camp was started in July of last year, and the Delin contract was completed before the close of December. The operating force numbered about half a hundred men; and they did their work rapidly despite the fact that they also had difficult conditions to meet and many outstanding obstacles to overcome. The deepest cut measures 162 feet on the high or inner side of the road and 80 feet high on the outer side where a rocky hump of the original mountainside was left undisturbed. This cut necessitated the excavating of substantially 65,000 cubic yards; and 18 tons of dynamite was used in one shot that disposed of about 25,000 cubic yards. The drilling and shooting entailed an outlay of $8,000.

In carrying on his work, Mr. Delin utilized three 1¼-yard Koehrig gasoline shovels; eight 4- and 5-ton Autocar trucks; two 9x8-inch, Type 20, Ingersoll-Rand portable compressors; three BBRA-13 "Jackhamers", and three R-12 "Jackhamers". How big a part gasoline played in carrying out the contract is evidenced by the fact that the shovels and the trucks consumed as much as 8,000 gallons of fuel in the course of a month. The nature and the quantities of the materials handled by the shovels and the trucks placed a very heavy burden on these facilities; and the conditions under which they operated added immensely to the mechanical stresses to which the equipment was subjected.

In carrying cuts down to the specified depths or grades, the material was removed in lifts by a series of benches having an average depth of from 10 to 15 feet. Inasmuch as a good many of the cuts were short and deep, both the shovels and the trucks had to operate on grades as steep as 40 per cent; and there were few of them that were as moderate as 20 per cent. Fortunately, neither contractor was obliged to haul his excavated material any distance—most of it being needed nearby



Picturesque glimpses of beautiful Lake Arrowhead.

to make fills of an extensive nature.

Besides the primary cut-and-fill operations, the contractors were required to do other forms of work in connection with the emplacement of corrugated metal piping for drains and culverts, the erection of guard rails, and the placing of no inconsiderable amounts of reinforced concrete. Regarding the latter, precast-concrete cribbing was utilized on the project at numerous points to support or stabilize the fills. This is something of a novelty in roadbuilding; and its success in the case of the Arrowhead Mountain road will be watched with interest by the engineering fraternity. The idea has much to commend it, and would seem to lend itself with peculiar fitness to the supporting of highways hung upon more or less precipitous slopes. The cribbing is made by the Massey Concrete Products Corporation.

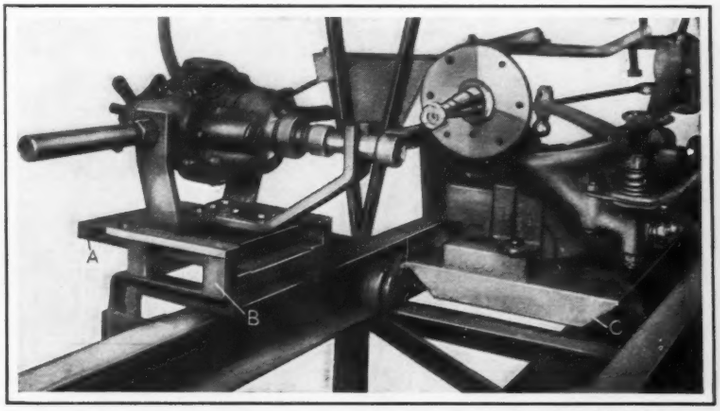
The average width of the new road is 24 feet, and the maximum grades range between 5 and 6 per cent. In short, this improved mountainside highway has slopes that can be mounted in high gear by virtually every up-to-date motor car. There are stretches of the old road that have 20 per cent grades, and much of that route has a gradient of 10 per cent. Therefore, the new road will not only be easier to climb and safer to descend but, as it traverses the south side of the mountain, will be open to traffic the year round—something that cannot now be said of the existing used highway forming part of the Rim-of-the-World Drive. The roadbed is largely made up of decomposed granite which pulverizes and packs solidly under traffic, thus giving a fine wearing surface.

Undoubtedly, this scenic route up the southern face of Arrowhead Mountain will add greatly to the popularity of the run between the lowlands and Lake Arrowhead; and the outlay of $624,406 on the part of the State and the Federal interests shows how keen they are to provide the motoring public with conveniences that will add to the traveler's security, comfort, and pleasure.

MOUNTING FOR AIR DRILL ALONG ASSEMBLY LINE

HERE and there along the assembly lines in automobile plants may be found air-operated drills which are used to set nuts, to drive screws, and to do other kindred work. These pneumatic tools should be arranged so that they can be employed with the least possible effort by the assemblers. A case in point is that of a mounting for an Ingersoll-Rand drill on the front-axle assembly line in the Racine, Wisc., plant of the Nash Motors Company. This drill serves to tighten castellated nuts on steering arms while these arms are being assembled on steering knuckles.

The air-driven equipment is mounted, as illustrated, on a simple slide A, which can be moved back and forth easily on base B set at right angles to the path of the assembly track. The axles that are being assembled are placed in carriages, such as shown at C; and these carriages are stopped at just the right point in front of the air drill for the nut-tightening operation. Besides relieving the worker of considerable manual effort, this drill arrangement also results in a proportionate saving in time.



Courtesy, Machinery.

General arrangement of the air-drill mounting along the front-axle assembly line in the Racine, Wisc., plant of the Nash Motors Company.

PORCELAIN-METAL JOINTS CAN BE SOLDERED

METALS can now be soldered to porcelain by a new process developed in the laboratories of the Westinghouse Electric & Manufacturing Company. This is an advance of no small importance in the electrical industry, which uses annually great quantities of porcelain as an insulator. The very character of porcelain, with its hard glaze, has made it difficult to effect a bond that would meet all the needs imposed.

The use of cement for this purpose has never satisfied the exacting requirements of the service. In the first place it is not watertight and therefore not as strong as porcelain. Neither is it a good insulator nor a good conductor. The new process—the nature of which is not revealed—is said to give a metallic joint that will not take up water; that is so tight against liquid and air pressure as to hold a high vacuum; that is stronger than porcelain; and that is a good conductor, therefore equalizing insulating stresses on the porcelain near it and often increasing its actual insulating value.

LENGTHENING SERVICE LIFE OF ELECTRIC BULBS

FROM the Lamp Development Laboratory of the Cleveland General Electric Company comes the interesting announcement that it has succeeded in discovering a means that will prevent the blackening of the inner walls of high-powered incandescent bulbs. It has been known, says *Power*, that the rising gas in such a lamp carries with it evaporated tungsten, which is deposited on the cooler top and sides of the bulb. This tungsten soot absorbs considerable light and also radiates heat which, in time, causes the glass to undergo devitrification and to become so hot as to deform the bulb and to render it useless. How to overcome this troublesome condition, which materially shortens the service life of these lamps, was the problem.

The remedy finally hit upon is a very simple one: it involves placing in each lamp before sealing just a tablespoonful of coarse tungsten powder. When a lamp has become blackened through use, this powder, by swinging the bulb back and forth, will effectually sweep the sooty deposit from the walls, thus making the glass as bright and clean as when new. In that state, the filament can be heated much nearer to its melting point without endangering the bulb and without shortening the life of the lamp, rated at 100 hours.

Portable compressor holding a prominent place in the Plaza de la Constitucion, Mexico City, Mexico, and furnishing air to operate pneumatic tools used in removing certain statues, known as "Pegasos de Querol", secured with cement to monumental columns. The statues are to be returned to the National Theater, where they originally formed decorative features.

To protect her newsprint industry, the legislature of the Province of Quebec, Canada, has recently given public notice that two trees must be planted for every one felled.

Making Fine Progress on Tunnel In Idaho Mine

By W. E. CARR

FOR the purpose of lowering operating costs, the Crescent Mining Company—a Bunker Hill & Sullivan property near Kellogg, Idaho, is driving what is known as the Hooper Tunnel. Such excellent progress is being made on it that perhaps a brief account of the undertaking would prove of considerable interest to a large number of our readers.

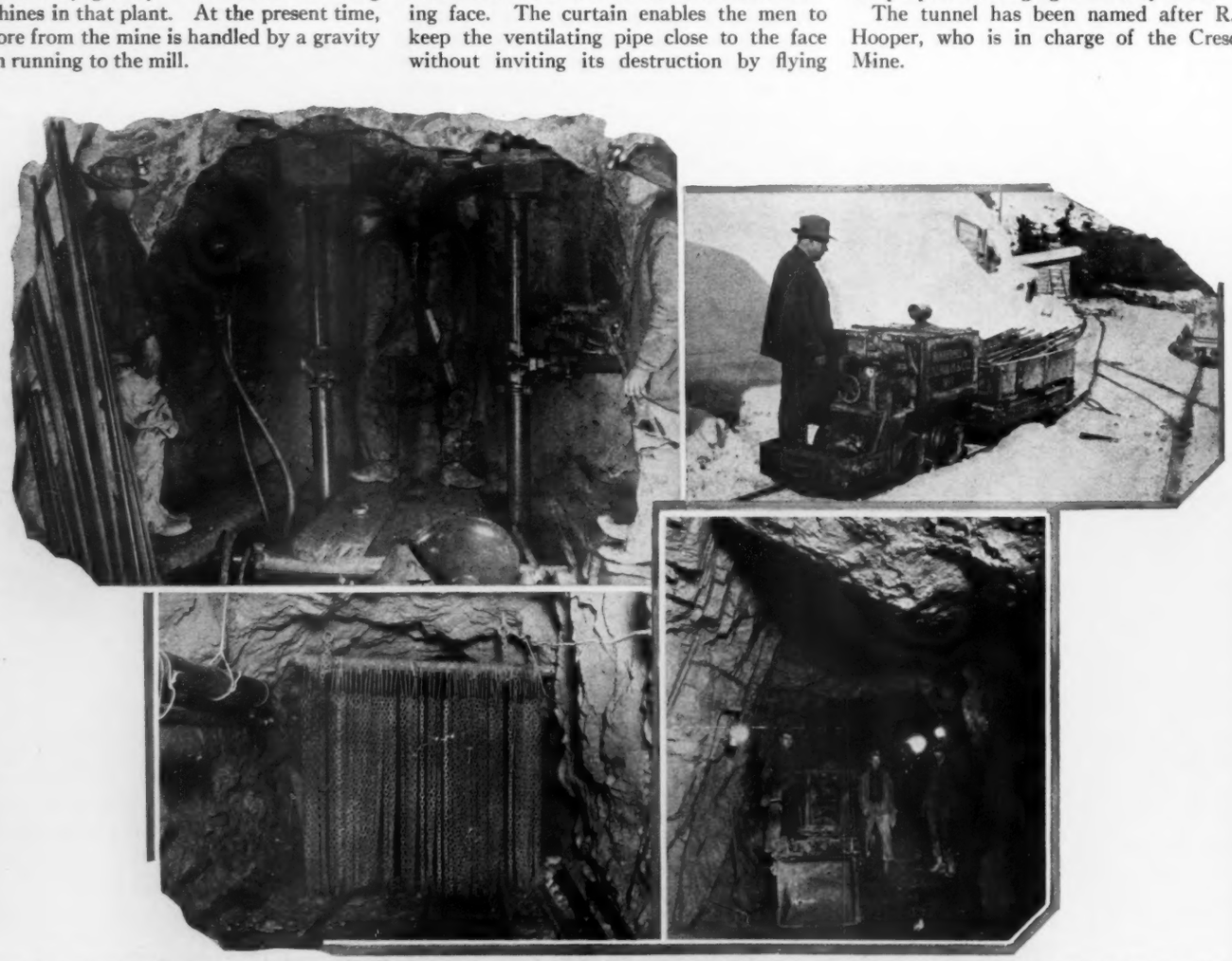
The work of driving the Hooper Tunnel is being done by J. Fred Johnson, contractor. The bore has a cross section of 8x8 feet, and, when completed, will be approximately 5,000 feet long. The object of the tunnel is to facilitate the transportation of ore from the Crescent Mine to a mill, which is located directly in front and below the portal of the tunnel. The ore issuing from this portal will be delivered to the top of the mill, whence it will move by gravity to the various treating machines in that plant. At the present time, the ore from the mine is handled by a gravity train running to the mill.

The rock through which the tunnel is being advanced is Wallace quartzite, and is of medium hardness with interposed harder ribs. The contractor is driving the tunnel with two S-70 Ingersoll-Rand drifters equipped with 42-inch guide shells. These guide shells permit the running of long changes—that is, 8 feet of hole with only three pieces of steel. The drill runners are putting in holes from 8 feet to 9 feet 6 inches deep, and they are drilling an average of 24 holes in three hours. The tunnel is being advanced at the rate of 15 feet every 24 hours with two shifts. Air is supplied at the heading at a pressure of 100 pounds per square inch. Mucking is being done with Butler mechanical shovels.

An interesting feature of this operation is the use of a chain curtain which is arranged so as to hang across the bore of the tunnel at a distance of about 50 feet back from the working face. The curtain enables the men to keep the ventilating pipe close to the face without inviting its destruction by flying rock at the time of blasting. This barrier is sufficiently heavy and strong to intercept fairly large pieces of rock blown rearward by the blast.

The curtain is suspended from a cross member which is supported by two chain loops—the loops being hung from two eyes that are driven into two holes drilled on opposite sides of the tunnel. The eyes are made of 1¼-inch round iron, and each is split up for a distance of 6 inches at the end that goes into the hole in the rock. Before the shaft of the eye is inserted in the hole, a wedge is entered into this split. When the eye is driven so that the shaft is well down to the bottom of the hole, the wedge serves to spread the split end and to anchor the eye firmly in the rock. Later on, if a trolley be used for the mucking trains, the eyes will be utilized for the purpose of hanging the trolley lines.

The tunnel has been named after R. P. Hooper, who is in charge of the Crescent Mine.



Top, left—Drifting with Ingersoll-Rand S-70's equipped with 42-inch guide shells. Right—Jack Aho on an electric locomotive shifting a load of drill steels at the Hooper Tunnel of the Crescent Mine. Mr. Aho is in charge of the tunnel driving for the contractor, J. Fred Johnson. Bottom, left—Chain curtain used to stop pieces of rock blown rearward when blasting in the Hooper Tunnel. Right—Butler mechanical shovel employed for mucking in the Hooper Tunnel.

Forbidding Richtersveld Retains Age-Old Hold on Its Copper Hoard

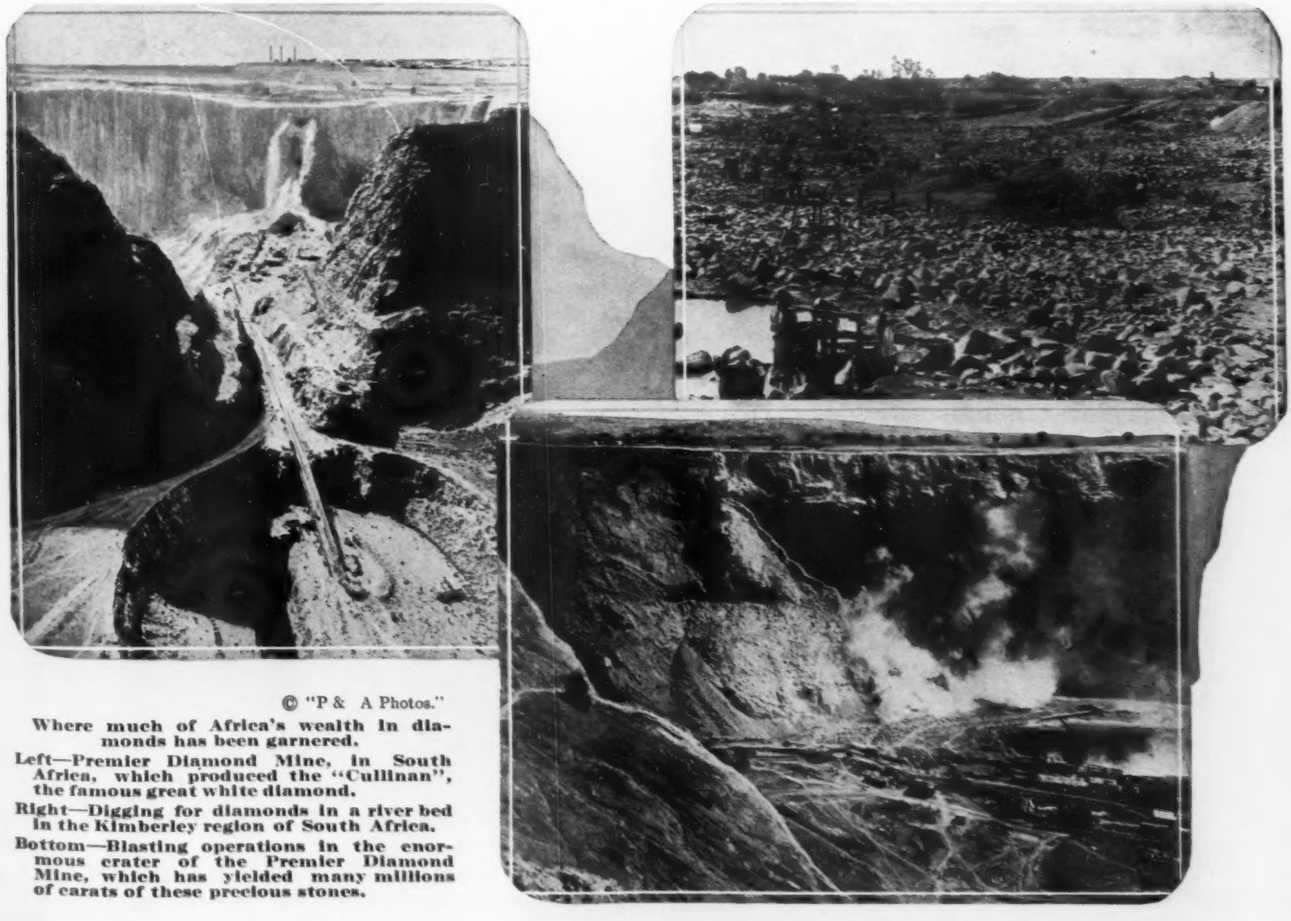
By OWEN LETCHER

WITH the exception of the Kalahari Desert tract, no part of the Union of South Africa is so little known as Namaqualand. This division of the Cape "North West" has recently come into prominence on account of the discovery of diamonds along the Atlantic littoral. The finest parcels of diamonds ever discovered in the history of the world have been found there along the dreary wind-swept seaboard; and so today, just to the south of the mouth of the Orange River, at Alexander Bay, private diggers are busily engaged winning from the bleak seashore stones of priceless worth, while the government-owned diamond diggings have been completely fenced in by barbed wire. From this inhospitable spot in South Africa, aeroplanes are flying to Cape Town—each carrying a king's ransom in brilliants. All this activity prevails, however, along the seaboard only.

In the interior of northern Namaqualand, in the country known as the Richtersveld, the serrated mountains and the well-nigh unmapped plains retain their pristine solitude; and the land remains as little settled and as unknown as it was at the dawn of time. It is a strange land, a merciless and cruel land without water save for a few remote water holes. It is a land of bitter cold in winter and of burning, fiery heat during summer; a land in which one may wander for months and never see trace of a human being, nor even watch the passage of an animal or the flight of a bird. And yet, notwithstanding all this, the Richtersveld has a strange and subtle fascination of its own. Its exceeding silences and untrammeled vastness cast an irresistible spell over one; and however much one may have suffered in that region from the torments of thirst and heat, there come times when one longs for a sight of the shimmering mirage and of "the peace that passeth all understanding": the peace of unexploited, pristine Africa. Those jangling telephone bells, those clanging street cars and hooting automobiles! How often have I felt that I would love to exchange their nerve-racking noises for the silences of the Richtersveld, where there are no tax collectors or mail days, and where a man can dress as he likes, roam where he will, and lead a life of unfettered freedom.

Where is the Richtersveld? Namaqualand is the oldest mining region of South Africa—that is to say, in so far as the regime of the white man is concerned. It was to Namaqualand that Simon van der Stel, first governor of the Cape, sent an expedition to search for mineral wealth in 1687. It is somewhat difficult to define the exact geographical boundaries of the Richtersveld. The term is generally applied to the whole area lying to the north of the Cape Copper Company's railway; but amongst Hottentots and prospectors it is not generally considered that the Richtersveld proper has been entered until the mountains of that name are in sight. And the Richtersveld Mountains may roughly be said to commence where an imaginary line drawn from the mouth of the Orange River through this arid and inaccessible country strikes the eastern end of the great bend or U formed by this stream.

Within the area of what may in its broadest



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Where much of Africa's wealth in diamonds has been garnered.

Left—Premier Diamond Mine, in South Africa, which produced the "Cullinan", the famous great white diamond.

Right—Digging for diamonds in a river bed in the Kimberley region of South Africa.

Bottom—Blasting operations in the enormous crater of the Premier Diamond Mine, which has yielded many millions of carats of these precious stones.

sense be termed the Richtersveld are 2,500,000 acres of land. Simon van der Stel, Le Vaillant, and some of the other early administrators, explorers, and geographers of bygone days had knowledge of this country, but it was not until nearly 100 years ago that anything approaching an exact account of the northern portion of Little Namaqualand and of its commercial possibilities was given to the public.

In the early thirties of the last century, this region was visited by a famous explorer, Capt. Sir James Edward Alexander. He was assisted in his adventurous journeyings by the British Government and the Royal Geographical Society, and he wandered far and wide through South-West Africa.

Nearly a century ago ore was mined at Numees and Kodas; carted by ox wagon to the Orange River; and then floated down the muddy waters of the great "Gariep" to a point about three miles from its mouth. I stood at this point a few months ago and gazed on the old stone houses which Sir James Alexander employed for the storage of the ore. Today they are in the new Namaqualand diamond belt which has proved itself to be the richest diamond-bearing field ever discovered in the history of South Africa. In less than six weeks, 12,500 carats of diamonds of superb quality, worth on an average between £10 and £12 per carat, have been recovered close to the bleak and desolate little indentation on the coast where the great Atlantic rollers come tumbling in, and known as Alexander Bay.

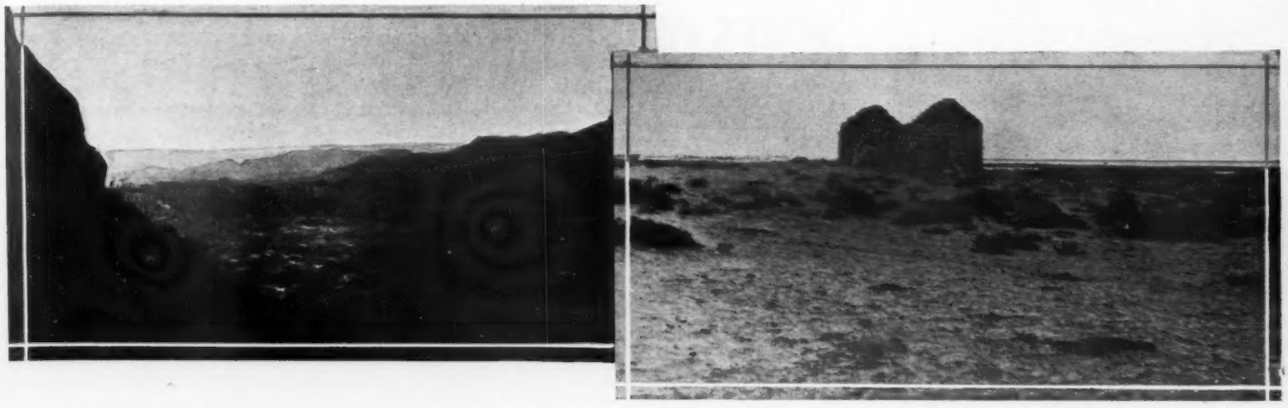
The mouth of the Gariep or Orange River is heavily sand barred. Were it not so, this stream would give ready access to the interior, and the history of the Richtersveld would have been very different. The early shippers of copper therefore had to employ Alexander Bay; but on account of the exposed nature of the place, transportation and water difficulties, and because of the general inaccessibility of the country, the Richtersveld copper industry fairly soon lapsed into the slumbering silences of the formidable mountain ranges. When Andrew Wylie, geologist of the Cape Government, visited the Richtersveld and presented to Parliament his verbose yet masterly report of 1857, there were a number of isolated copper propositions at work in the great bend of the Orange River.

If one has traveled through that country today and lets one's mind wander back to the conditions that obtained there in the "fifties" —when the steam engine was still a tremendous novelty, and when mules and bullock teams had just commenced to cart ore from the rich mines of Messrs. Phillips and King at Springbokfontein and Ookiep to Hondeklip Bay, then there is no reason for wonderment that the Richtersveld mines had to bow to force of circumstances and close down.

Since those days, the country has changed not one iota: there has been no real development. The old *kokerboom* trees stand sentinel-like over a vista of forbidding solitude. The trek Boers and the Hottentots living in this region are as unsophisticated in regard to affairs of the outside world as ever they were. The cults of bobbed hair and "black bottom" have not entered into their lives; and Valentino whiskers and Oxford bags have been with them always. They know and care nothing about Easter holidays, the Kellogg Pact, the income tax, or the situation in Shanghai. They think in terms of the production of infants, food, stock, mat houses, water, and concertinas. Neither they nor the country have changed in the last century. But the quickening, strenuous outside world far beyond the mountain ranges and the sand dunes has altered a whole lot.

We have evolved the motorcar; and the modern high-powered automobile with balloon tires has rendered the opening up of the Richtersveld possible. Van der Stel's journey to Namaqualand occupied six months. The other day a Chrysler made the trip from Alexander Bay to Cape Town and return in 52 hours. And now Moth aeroplanes are further shortening the bridge of time and flying in a few hours from northern Namaqualand to Cape Town with thousands of pounds worth of diamonds.

Top, left—High in the mountains of the Richtersveld running a survey. Right—A trench in the Alexander Bay diamond fields which are proving amazingly rich. Bottom, left—A much garbed group of Richtersveld Hottentots. Right—The author on the edge of the Cave of Heije-Eibeb in the Richtersveld.



Left—Looking from the mountains of the Richtersveld toward the Outjogariep—the wildest part of the Union of South Africa. Right—What remains of the old stone houses, near Alexander Bay, where copper ore was stored 90 years ago.

Some few months ago I proceeded to this wild and little-known region on behalf of the late Isaac Lewis, the well-known South African financier and mining magnate. Mr. Lewis desired me to examine some of the old copper mines there, as it was his intention to reopen them and to form a company to acquire and to operate many mineral leases in the Richtersveld and Namaqualand. We had a most adventurous trip. My companion on this journey was E. Heyes—Heyes of the Richtersveld, certainly one of the most remarkable characters I have ever come across: a man who knows that country from end to end, a dynamo of human energy who takes delight in scaling unknown mountain ranges and who has had experiences in the Richtersveld, South-West Africa, and many other portions of the world, experiences such as would make Zane Gray's Wild West fiction seem commonplace and uninteresting.

Through a breakdown in the transport arrangements we were marooned at the Numees water hole for a week. We might have been living on another planet for all the signs of life that were to be observed. There were just Heyes and myself, and an old baboon up in the mountains who used to bark at us in the early morning. We climbed the ranges and searched the spacious landscape for a sign of human beings, the smoke of a camp fire, or the movement of a wagon; but the Richtersveld, as usual, was unpeopled and inhospitable, majestic and desolate.

On that journey we climbed the serrated Richtersveld Mountains and gazed across to the impregnable wall of the Outjogariep in South-West Africa—a range that is supposed to contain the mysterious Bushman's paradise. Unscaled and well-nigh unscalable, it presents yet another sanctuary of Nature upon which the foot of the white man has yet to tread.

Later we scrambled up the Great Tatasberg and saw a ribbon of gleaming silver—the Orange River—lying deep down below in the chasms of the mountains. And we visited the wonder hole which Heyes descended many months ago. This is a curious vent in the earth's surface which Sir James Alexander depicts on his map as the Cave of Heije-Eibeb—"The Cave of the Three-headed Bird". We finished up that journey by struggling into Port Nolloth on a certain midnight completely exhausted and famished, with tongues and lips swollen from thirst. Port Nolloth is a miserable little hamlet on the bleak Namaqualand coast; but to us, after the hardships and privations of the Richtersveld, it was a veritable suburb of paradise.

A company was being formed when Mr. Lewis, the sponsor and guiding spirit of the enterprise, died. We had established a camp in the Numees Mountains and had reopened an old copper mine there. I had proposed purchasing a portable-compressor outfit to expedite the work of development; but with Mr. Lewis' demise all our hopes and ambitions crashed and we have not since been able to find anyone to take his place.

And so the Richtersveld, with its copper mines, has again reverted to the primeval solitudes. The sounds of blasting that a year or two ago reverberated through the old Numees Mountains have ceased; the camp that we established with such infinite toil has disappeared; and it almost seems as if man must bow to the inexorable harshness of Nature in this realm of tangled and forbidding mountain ranges, where thirst and hunger and desolation make existence a problem, and death so very easy! But the copper remains there.

Perhaps, one day, others will go back and reap a rich harvest where we sowed amongst those ranges that many years ago saw the very beginning of mining in South Africa under the guidance of the white man's brains.

The Chinese Government has decided on the meter as the standard measure of length.

Left—On the "Coast of Murders". Looking seaward from northern Namaqualand. Right—The northern fringe of the Richtersveld, on the Orange River.

VACUUM CLEANER OF AID IN BURNING OUT STUMPS

INDUCED draft, created by an ordinary household vacuum cleaner, is being used to great advantage by the Puget Sound Power & Light Company for the purpose of expediting the burning of stumps in clearing logged-off lands for cultivation. For the work, writes an official of the company, the dust bag of the vacuum cleaner is replaced by a manifold with connections for eight hose lengths, each terminating in a piece of iron piping.

After numerous holes have been drilled at ground level in a stump, the practice is to start charcoal fires in them and to insert an air line in each. The air lines, acting as blowpipes, are pushed farther into the holes as burning progresses—the separate fires, finally coming together at the center, stimulating ventilation and causing the part of the stump that is above ground to be consumed. The time required to do this depends, of course, on the size of the stump: one 6 feet in diameter was thus burned, root and all, in eleven hours. In getting out sound as well as rotted roots, substantially the same procedure is followed.

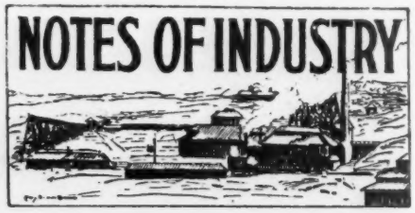
The cost of modifying a vacuum cleaner, as described, ranges from $20 to $30, and that of operating the unit varies with the size and the condition of the stumps. For instance, in removing eleven large ones, the charge for current used came to only $2.75; and as for attendance, an hourly visit suffices to manipulate the air lines. Digging, blasting, and pulling are entirely done away with by this method; and even the work of releveling afterwards is considerably lessened in consequence.

NEW REFRACTORY BRICK

SOMETHING new in refractory bricks, that also involves a departure in the method of lining cupolas, blast furnaces, open-hearth furnaces, coke ovens, etc., has been introduced by the Covell Corporation with headquarters in Philadelphia, Pa. The bricks are made with lugs, and these lugs form numerous spaces that are filled in with a plastic refractory material after the bricks are in place. The material is applied under air pressure by the use of a "gun". The resulting joints are very firm, in fact are said to be stronger than the bricks, themselves. Because of this method of binding, known as the "Co-Weld-Cor" system, the bricks need not be laid as carefully as would otherwise have to be the case. The same system, under the name of "Weldcrete", is being applied to masonry construction in general.

CORRECTION

In our February issue we mistakingly stated that the facade of the Senate Office Building in Washington, D. C., was finished with Beaver Dam marble. Beaver Dam marble was used in the main rotunda and in the stairway of that structure, but Vermont marble was employed for the exterior of that Government edifice.



Owing to the remarkable expansion of the copper-mining industry in Canada, it has been decided to establish two refineries in the eastern part of the Dominion.

And now we have the refrigerated airplane! This may sound paradoxical, inasmuch as most of us know that the higher we go the colder it gets. Be that as it may, a New Mexico firm has ordered three planes completely equipped with refrigerating apparatus for the shipment of shrimps to California.

Investigations conducted by the United States Bureau of Mines during the past year have established the fact that propane and butane can be utilized to advantage in the enrichment of illuminating gas. One plant in the Middle West is using butane in the daily production of 1,500,000 cubic feet of carbureted water gas. Propane and butane are low-boiling hydrocarbons, by-products of the petroleum industry, that heretofore have gone to waste for want of a market.

A saving of $256,027,431 in one year is credited to chemical research because of the diversion of 5,558,243 tons of cottonseed from the refuse pile into channels of consumption. Hulls only are now regarded as waste; and even they contain marketable products such as furfural, acetic acid, alcohol, tar, and other hydrocarbons, as well as potassium and compounds of carbon and sodium. The recovery of these chemicals on a commercially profitable scale is now just a matter of time.

The population of Melbourne, Australia, has reached the 1,000,000 mark.

Ninety-one miles of diamond-drill core was removed from the mines and prospects of Ontario in 1928, or nearly double the footage ever made there by the diamond drill in any year. This is an index of the magnitude of the exploratory work being done by the mining industry in that province, which produced minerals to the value of $100,238,933 in 1928—$10,000,000 worth more than in 1927.

The world demand for muskrats in 1928 exceeded the supply by substantially 15,000,000 pelts, according to estimates made by the United States Biological Survey. Sixty per cent of all fur coats are made from the skins of muskrats and are sold under a variety of names.

Detecting fishing banks by means of the echo-sounding device is a new and peacetime use for an instrument that served during the World War to locate enemy submarines.

As a part of its program to determine the effect of an explosion on an explosive substance nearby, the United States Bureau of Mines has been taking photographs of the actual travel of sound-pressure waves emanating from an explosion. The purpose of the work is to throw more light on the sensitivity of explosives and to produce safer explosives for use in coal mines.

The mountains of slag at the Old Dominion Mine at Globe, Ariz., are being put to commercial use, thanks to the research chemist. The first unit of a local brick-making plant is now drawing upon that source of raw material at the rate of 300 tons daily in turning out a very hard brick that is said to be especially suitable for paving highways.

Including national and international routes, Germany now has in regular service 76 air lines

What is said to be a world record in paper-making was established recently at Fort William, Ont., when a single unit in the plant of the Great Lakes Pulp & Paper Company produced 151 tons and 340 pounds of newsprint in a 24-hour day. The previous record of 147 tons was held by the Gatineau Mill of the International Pulp & Paper Company.

During the year 1928, the salvage department of one of the largest industrial plants of the United States was able, at a cost of but $400,000, to reclaim metals having a market value as scrap of $3,700,000.

October 21 marks the fiftieth anniversary of the invention, by Thomas A Edison, of the first practical incandescent lamp. The occasion is to be fittingly celebrated this year by Light's Golden Jubilee, which is to come to a climax on the anniversary date with "The Night of Light". The plans for the jubilee, which is to be nationwide, are now being formulated.

Most of us have had more or less experience with the deterioration of rubber goods and will, therefore, be interested to learn that, as the result of a recent discovery, rubber can be protected against the destructive effects of oxygen. According to the *Engineer*, a substance called neozone is mixed with the compound and is said to cause the goods made of it to last almost indefinitely.

The consumption of tin in the United States is so large that the annual imports of that metal amount to about one-half of the world's total production.

Losses sustained in the kiln-drying of lumber, as generally practiced, have been the object of investigation by the Canadian Forest Products Laboratories. Improvements in kiln operations suggested as a result of these studies have already brought about a marked reduction in the average loss due to faulty drying.

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EDITORIALS

CAPITALIZING ACADEMIC EXCELLENCE

THE able president of Stevens Institute of Technology, Hoboken, N. J. has adopted a "sliding scale of tuition" which is purposely designed to attract to the institution the best of the students within the area served. Dr. HARVEY M. DAVIS, the president, has stated that "A straight A student"—one prominent in extracurricular activities—"might get remissions which would reduce his fees from $2,400 to as little as $300 for four years."

The purpose of this sliding scale is to spur the students to academic achievements that are measurably above the dead level, so often aimed at, of merely getting by. Of course, this rather revolutionary departure has aroused considerable discussion for and against it. In replying to his critics, Doctor DAVIS has made clear the limitations of the scheme. As he puts it:

"After a student has acquired a large number of honor points counting towards remission, the law of diminishing returns will set in; and merely by doubling the time devoted to studies the student will not be in a position to double the number of points earned. A saturation point will be reached, and the curve will then lean toward student expression in extracurricular activities." This arrangement is counted upon to stimulate both regular studies and extracurricular activities.

This innovation will be watched with much interest by both the faculties and the student bodies of a great many educational institutions. On the face of it, Doctor DAVIS has hit upon a thoroughly practical and a decidedly persuasive means of encouraging his students to greater effort.

THE RATE AT WHICH WE GROW

AGAIN the United States Bureau of Census faces the stupendous task of ascertaining the population of the country. Next year this work must be done; and the enumerators detailed to gather the data must do so in the course of a single month. Just think of it, in that brief while they must obtain certain essential facts having to do with more than 120,000,000 persons! No wonder an army of 100,000 enumerators will be required for the purpose; and, before that force is turned loose, each and all of them will be carefully instructed so that they may be qualified for the important duties assigned them.

The first census of the United States was made in 1790, and the population of the country then totaled a trifle less than 4,000,000 souls. The taking of that census required thirteen months. As we have said, the 1930 census will be taken in one month, and it will have to record a population more than 30 times as large as that of 1790. Our people then occupied a territory aggregating 868,000 square miles. Today, the area of continental United States is 2,974,000 square miles—that is, 3.4 times as great as it was when the first census was taken, and yet this far-flung region must be canvassed in one-thirteenth of the time permitted in 1790.

According to WILLIAM M. STUART, director of the Census Bureau, the population of the United States is increasing at present at a rate of about 1,400,000 people annually. He points out that: "In 1790 there were in the United States only six cities having as many as 8,000 inhabitants. The population of these cities formed a little more than 3 per cent of the total population of the country. In 1920 there were 924 such cities, and their population was nearly 44 per cent of the total."

PAN-AMERICAN AERIAL CROSSROADS

THE Panama Canal has appropriately been called the "maritime crossroads" of the Western Hemisphere. Through that waterway move annually ships bound hither and thither to all parts of the world bordering upon the Atlantic and the Pacific oceans or to the seas tributary thereto. And now, thanks to the pioneer labors of intrepid airmen, Panama may in the near future become the aerial crossroads of flying machines bound north and south, east and west, in shortening the postal spans that today lie between the two neighboring continents.

It is entirely practicable to communicate by cable and wireless between North and South America, and with the aid of the connecting telegraph lines to reach speedily well-nigh any place of importance on the two continents. Yet the vast volume of verbal intercommunication is effected by letter. There are many reasons for this, and most of these will be readily recalled without the need of enumeration here. Such being the case, it is easy to understand how much of a boon airplane mail routes may prove to Pan-America in the rapid transporting and delivering of correspondence—the lines in this service using the Canal Zone as a central point for redistribution and forwarding.

Today, certain cities in South America are thirty or forty days away from New York by mail, and it is quite feasible to cut down this time interval to eight or fifteen days, respectively, by substituting aircraft for the prevailing means of transportation. Much has already been done to this end, and much more will inevitably be done as the reliability of the service increases and the scope of the routes widens in response to demand. Surely, even present accomplishment seems wonderful in view of the relative newness of air-mail service; and what may we not reasonably expect in the near future in thus breaking down the barriers of distance?

CANADA'S LATEST SPLENDID POWER PROJECT

WHATEVER may be the ultimate outcome of the plan to convert the St. Lawrence River into a link between the Great Lakes and the Atlantic for ocean-going ships and, incidentally, to develop great blocks of hydro-electric energy through a compact between Canada and the United States, it is now apparent that the spirit of the Dominion is to stand on her own feet and to utilize for her own industrial betterment a considerable share of the power available in the waters of the great river serving in part as a boundary line between the two neighboring countries.

A short while back, authority was given the Beauharnois Light, Heat & Power Company to construct a power canal on the St. Lawrence between Montreal and Ottawa for the purpose of developing half a million horsepower of electrical energy. A significant restriction in the charter for the undertaking is that the power shall be sold exclusively to Canadian users and that none of it shall be sold either to a foreign country or to any Canadian company that exports power. The manifest purpose of this provision is to encourage the upbuilding of a great industrial center around or near the site of the projected central station. A block of 500,000 horsepower produced in the manner proposed would not only suffice to energize many great industrial plants but could be sold at low and very attractive rates to users.

The intention is to dig a power canal at that point on the river that lies between Lake St. Francis and Lake St. Louis; and the canal would have a length of 14 miles, be from 600 to 800 feet wide, and have a depth of 27 feet. The work would necessitate the excavating of substantially 200,000,000 cubic yards of earth and rock; and it has been estimated that an army of 2,000 men would be required for a period of three years to complete the project. The intention is to erect the power plant or plants at Lake St. Louis, where a volume of 40,000 cubic feet of water per second will be allowed the operators for the generation of electric current. In its entirety, the undertaking will call for an expenditure of not less than $65,000,000.

Should the deep waterway between the Great Lakes and the Atlantic Ocean via the St. Lawrence become an accomplished fact some day, the Beauharnois power canal could and probably would be made a unit in the vaster scheme.

WHY WE ARE AS WE ARE

FROM time to time we have been told by both foreign and American industrial leaders and investigators why we enjoy the full measure of prosperity that we do. These pronouncements have been varied and, every now and then, quite contradictory; but none of them has denied the abundant evidences of our material well-being. The foreign investigators have been especially keen in their search for the reasons for our outstanding success in industry, trade, and finance, because their desire has been to make it possible for their own countries to attain similar eminence.

The National Bureau of Economic Research has just issued a report that crystallizes the main points of agreement developed by these visiting foreigners during the last six or seven years; and a reading of them will be illuminating to many of us that have taken our prosperity largely as a matter of course and without considering the fundamental reasons for our blessings. To quote from the *New York Times:*

"Our unrivaled natural resources. Some foreign observers emphasize this, while others emphasize the energy and the organization which utilizes them.

The relative scarcity of labor and the prevailing high wages.

The progressive development of labor-supplementing machinery.

Our great domestic market, which makes possible mass consumption as well as mass production.

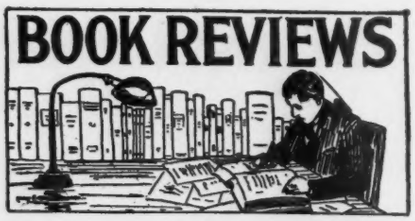
The high premium which has been placed on management and organizing capacity.

The improvement of industrial relations and the labor-union recognition of mutuality of interest.

The openmindedness of American management and the consequent raising of the standard of management for the nation as a whole.

The dominant national trait of optimism and energy: the mobility of the individual as to place and calling".

Favorable as so many of the foregoing factors are, their continuance is by no means assured unless we recognize our responsibilities and give serious heed to how we use and exploit our natural resources. Furthermore, while so much of our prosperity is the outgrowth of a domestic capacity to absorb the bulk of the fruits of our labors, still we must depend more and more in the future upon foreign markets to dispose of much that we shall have to sell or to lend. This means that we must learn to think internationally and to win the good will of the foreign buyer by the way in which we conduct ourselves in the markets of the world.



CHEMISTRY IN MEDICINE, edited by Prof. Julius Stieglitz and a staff of advisory editors. A work of 757 pages, published by The Chemical Foundation, Inc., New York City. Price, $2.00.

THE purpose of this book is to inform both the general public and the medical practitioner at large of the long steps forward that chemistry has made in helping to protect and to preserve life—particularly the lives of children so that the little ones can have a better chance to reach maturity and the broad years of fuller service. The ten chapters deal successively with different phases of this vital subject; and each topic is handled by a writer professionally fully qualified to deal with it. The final chapter has to do with chemotherapy—described as "a hope of mankind". All the articles have been written with careful regard to lucidity, so that the layman can easily understand them. It is not inappropriate to call them dramatic and often even thrilling. With fuller knowledge on the part of the laity there will inevitably be better coöperation with the man of medicine, and that is one of the purposes of the book. As a matter of fact, there is compressed within the covers of the volume a wealth of information which even a physician might spend a year in obtaining in a medical library.

VIBRATION PROBLEMS IN ENGINEERING, by S. Timoshenko, Professor of Engineering Mechanics, University of Michigan. An illustrated work of 351 pages, published by D. Van Nostrand Company, Inc., New York City. Price, $4.50.

IN this book the author deals with the fundamentals of the theory of vibration and with their application to the solution of technical problems as illustrated by various examples. Many of these have been taken from actual experience with the vibration of machines and structures in service. While the subject covers a special field of engineering, still its treatment in the present volume should prove helpful and informative to a large circle of the engineering fraternity.

A CRUISING VOYAGE ROUND THE WORLD, by Capt. Woodes Rogers. An illustrated volume of 320 pages published by Longmans, Green & Co., New York City. Price, $4.00.

THIS book was first published in 1712, and now appears again both to entertain and to emphasize some of the many amazing changes that have taken place in nautical life in the course of more than two centuries. Woodes Rogers had been impressed by the way in which France and Spain had succeeded in monopolizing the trade of the South Seas; and being a true Britisher he considered the situation an evil and one calling for correction. Accordingly, he set about in 1708 to obtain funds and to outfit two ships that were to visit the profitable region of the South Seas and bring home to England the riches that others had previously enjoyed exclusively.

With that responsive spirit of adventure characteristic of his nation, Rogers' men were recruited from such miscellaneous workers as "tinkers, tailors, haymakers, pedlars, fiddlers, etc." The times and the nature of man afloat provided local color aplenty: and Rogers' book makes absorbing and illuminating reading from cover to cover. In those days the private trader and the pirate differed but little in principle and not infrequently in practice. The strong man invariably had his way, whether it was right or wrong.

ENGINEERING ENGLISH, by John Hubert Scott, Professor State University of Iowa. A book of 321 pages, published by John Wiley & Sons, Inc., New York City. Price, $2.75.

WHILE we cannot subscribe to the author's statement that there are different sorts of English—and each of them properly a medium of expression for some particular department of life or professional activity, still we are in principle in full accord with his manifest effort to encourage recognition of the value of the study of English on the part of those acquiring an engineering education. All too frequently one is amazed at the crudity of the English used by engineers in their letters and their reports—papers more often than otherwise intended to inform and to influence men that are not engineers but financiers and business executives. There is room for a tremendous improvement in clarity of expression; and to a considerable extent we believe Professor Scott's book can help towards betterment.

Piedmont Carolinas is the title of a brochure published by the Industrial Department of the Duke Power Company, Charlotte, N. C. This booklet gives a brief but comprehensive presentation of the natural advantages and the notable industrial activities of the two Carolinas. Much of the information is generally unfamiliar to the nation at large.

A Study of Body Radiation, by L. B. Aldrich, is the title of a pamphlet published by the Smithsonian Institution, Washington, D. C. The studies upon which the paper is based had for their object the ascertaining of certain facts bearing directly upon body temperatures in relation to proper ventilation.

Dominion Fuel Board, Second Progress Report, 1923-28. This report brings up to date the efforts of the Dominion of Canada to utilize its own fuel resources and to make itself as far as practicable independent of imported fuel. It contains much valuable information on this important subject. The booklet is published by the Department of Mines, Ottawa, Canada.

Expansion or Growth, the Story of a Chemical Industry, by Dr. John E. Teeple. This pamphlet contains the Perkin Medal Address, 1926, and is an account of the development of the potash industry at Trona, Calif. The booklet can be had gratis, on request, from The Chemical Catalog Company, Inc., New York City.